TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Arrowsmith Timber Supply Area Analysis Report

September 2001

BRITISH COLUMBIA

Ministry of Forests

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Arrowsmith Timber Supply Area Analysis Report

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Preface

This report contains a timber supply analysis and socio-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia.

To determine allowable timber harvesting levels, the chief forester must have an up-to-date assessment of the timber supply based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code (FPC) of British Columbia Act* and official land-use decisions.

Focusing the assessment on the implications of current practices rather than looking at a number of different management schemes expedites the analysis process, allowing analysis of all TSAs in the province on a regular basis. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the chief forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social an economic objectives of the Crown. The socio-economic analysis provides the chief forester with some of the information necessary for these considerations.

This report is the third of five documents that will be released for each TSA as part of the Timbe Supply Review. The first two documents are the information report and the data package. A fourth document called the public discussion paper will summarize the technical information and will provide a focus for public discussions of possible timber harvest levels. The fifth will outline the chie forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Arrowsmith Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short- (next 20 years), medium- (21 to 100 years) and long- (100 to 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Arrowsmith timber supply area is located on the southern half of Vancouver Island and includes the adjacent Gulf Islands. Relative to other forest management units on southern Vancouver Island, the timber supply area represents a relatively small and fragmented timber harvesting land base. The Arrowsmith timber supply area covers approximately 200 000 hectares. In 1998, the Duncan Forest District and the Port Alberni Forest District amalgamated to form the South Island Forest District. The South Island Forest District administers the Arrowsmith timber supply area, as well as a number of tree farm licences from offices located in Port Alberni and Duncan.

The results of this timber supply analysis suggest that, given data and management assumptions that reflect current information and practices, the Arrowsmith TSA can support a harvest level of 357 000 cubic metres per year, 11% below the current AAC, for the next 10 years. This harvest level has three distinct parts: 1) a harvest level of 6300 cubic metres per year can be maintained for the ten years remaining in the term of the alder-leading forest license; 2) a harvest of 11 000 cubic metres per year can be maintained in Clayoquot Sound, 20% below the current partition of 13 700 cubic metres; 3) the remainder of the harvest, 339 700 cubic metres per year, comes from areas outside of Clayoquot Sound, 11% below the current partitioned AAC of 380 000 cubic metres. After one decade, the projected harvest level declines by 11% per decade, reaching a steady level of 286 250 cubic metres per year after decade seven.

A series of sensitivity analysis showed that data and management uncertainties affect timber supply projections to varying degrees, some with positive impacts and others with negative impacts.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies substantially on harvests from these stands for the next 70 years. The short-term supply is also sensitive to changes in future merchantable growing stock. A shortage of merchantable timber is anticipated in about 14 decades that affects the amount of short-term harvest that can be taken.

The uncertainties with the largest potential to affect the base case projection of short-term harvest levels (next 20 years) are estimates of timber volumes in existing stands, the size of the timber harvesting land base, and amount of area allowed below green-up height on the timber harvesting land base at any time. An inventory audit completed in 1999 showed that the inventory estimate of volume in mature stands (over 60 years old) was approximately 4% above the estimate derived from ground samples. This small apparent overestimation in inventory volumes was not statistically significant.

There is currently no evidence to suggest that the timber harvesting land base has been over estimated. The size of the timber harvesting land base has in fact decreased 12% since the previous analysis in 1995, due primarily to new protected areas, woodlots, community forests and *Forest Practices Code*. Significant areas of Crown land on the east coast of Vancouver Island are considered part of the 'fragmented' land base where Crown land parcels are often small and surrounded by private land or adjacent to communities. These fragmented areas are difficult to regularly access and are estimated to comprise 6% of the timber harvesting land base. The fragmented land base has been modelled in the base case with additional forest cover constraints to reduce their harvest contribution. Sensitivity analysis in which the fragmented parcels were removed from the timber harvesting land base showed reductions to the harvest level in the mid- and long-term of approximately 6%.

Increased managed stand yields can also potentially increase short-term harvests. Increased volumes available in the future help alleviate apparent long-term supply problems, potentially making more timber available in the short term for harvest. Similarly, decreasing managed stand yields decreases the timber supply in the short term.

Executive Summary

Medium-term (21 to 100 years from now) timber supply is affected by many of the factors tested through sensitivity analysis. Because the long-term harvest level is about 20% lower than the starting harvest level, changes in factors that alter either the total amount of existing volume, or the ability to access existing volume during the first 100 years will affect medium-term timber supply. The medium term is affected by changes in: the size of the timber harvesting land base; volumes from existing and managed stands; minimum harvestable ages; and harvest rule assumptions.

Changes in the estimates of volumes in existing stands and in the amount of the land base that is available for harvesting have direct and approximately proportional effects on medium-term supply. In addition, changes in the size of the timber harvesting land base cause proportional increases or decreases in the long term. Increases in minimum harvestable ages exacerbate long-term timber supply problems and decrease the short- and mid-term harvest forecasts.

Another factor with potential impacts on medium- and long-term timber availability is the rule used to set harvest priority. The analysis showed significant impacts when the highest priority was placed on stands that had just reached minimum harvestable age (youngest-first rule), or when the harvest of stands is scheduled randomly, rather than the relative oldest first rule used in the base case. It is unlikely that younger stands would always be given higher harvest priority than older stands, or that the harvest schedule will be completely random. Nevertheless, the analysis showed the potential for changes to harvest priority to have impacts on timber supply.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand volumes. Uncertainties about the implementation of landscape-level biodiversity can have small impacts on the long-term harvest. Increases in seral-stage biodiversity requirements will reduce the long-term harvest level.

If site productivity is underestimated for existing old-growth stands as suggested by recent research, yields in regenerated stands could be significantly higher than in the base case harvest forecast which would boost long-term supply directly.

In summary, this analysis indicates that based on current inventory, growth and yield, and forest management information, the Arrowsmith TSA could support a harvest level of 357 000 cubic metres per year, 11% lower than the current AAC. This is largely a result of the 12% reduction in the timber harvesting land base area. This base case harvest forecast is comprised of an 11% reduction of the conventional harvest outside Clayoquot to 339 700 cubic metres; a 20% reduction of the Clayoquot Sound harvest to 11 000 cubic metres and a maintaining of the alder harvest at 6300 cubic metres. The analysis indicates that several factors related to the current forest inventory, land base, and management regime could affect timber supply. However, with the exception of underestimating site indices for old-growth stands, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis.

The socio-economic analysis for the Arrowsmith TSA indicates that the current AAC of 400 000 cubic metres can support approximately 396 person-years of direct employment across the province. Residents of the TSA account for about 69% of this direct employment. Direct forestry sector activity in the TSA supports a further 488 person-years of indirect and induced employment across the province.

From 1998 to 2000, the harvest averaged 290 031 cubic metres per year, or about 73% of the allowable annual cut. Employment levels would have adjusted downward to match the lower harvest rates, but this type of fluctuation in employment is not uncommon and the harvest is expected to increase.

The base case harvest forecast indicates an immediate 11% reduction in the timber supply to a harvest level of 357 000 cubic metres per year. Assuming the timber supply is, on average, fully harvested and processed, this lower volume could lead to a reduction in direct forestry sector employment of about 40 person-years. Whether the 40 person-years would reflect active jobs depends on companies' employment levels at the time and the way in which companies respond to the reduction. Any reduction, however, will affect those workers who are part of the marginal labour force and who are already faced with more sporadic periods of work.

From 1998 to 2000, the average annual harvest of 290 031 cubic metres per year provided the provincial government with average revenues of $12.4 million per year. Fully harvesting the AAC could result in government revenues of $17.1 million per year. This increase would be mainly the result of higher stumpage revenues.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect the growth and development of another part of the forest resource, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood. Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the chief forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

** Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The British Columbia Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Arrowsmith TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Timber supply analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. This is followed by a summary and conclusions for the timber supply analysis. Section 7 shows results of a socio-economic analysis for the Arrowsmith TSA. Appendixes A and B contain further details about the data and assumptions used in the analysis.

As part of the timber supply review (TSR), information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis provides information for the chief forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Arrowsmith TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by assessing employment and income implications of timber harvesting level projected in the base case.

The socio-economic analysis includes an estimate of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands related, processing, and silviculture. Employment is measured in terms of person-years*. Employment income is calculated using average industry income estimates.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Introduction

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Indirect and induced employment figures were calculated using the Arrowsmith TSA and provincial employment multipliers* developed by the Ministry of Finance. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

1 Description of the Arrowsmith Timber Supply Area

The Arrowsmith Timber Supply Area (TSA) is located on the southern half of Vancouver Island and consists of several fragmented areas located within the South Island Forest District. This TSA is one of eight in the Vancouver Forest Region and with an area of approximately 200 000 hectares. The TSA shares borders with Tree Farm Licences (TFLs) 25, 44, 46, 54 and 57, and also with reserves, parks, municipalities and private lands. The TSA is administered by the forest district office in Port Alberni and a field office in Cobble Hill. Compared to the surrounding TFL lands, the TSA provides a comparatively small, albeit important, proportion of the timber harvest on the southern part of Vancouver Island.

According to the 1996 census, the population of the Arrowsmith TSA had increased 10% from 1991, to approximately 545,500 people. The major population centres are Victoria, Duncan, Ladysmith, Nanaimo, Parksville, Qualicum Beach and Port Alberni. Other smaller communities include Tofino, Ucluelet, Lake Cowichan, Nanoose, Chemainus, Union Bay and Fanny Bay. Population density in this TSA is particularly high along the east coast of Vancouver Island, and is expected to continue growing at a strong rate.

The Arrowsmith TSA extends from the mountainous terrain of southwestern and central Vancouver Island, to the moderate relief of the Nanaimo lowlands and the Gulf Islands. The forests in the Arrowsmith TSA are mainly comprised of Douglas-fir, western redcedar, western hemlock and true firs (balsam). On the east side of the island, a long history of timber harvesting has resulted in the establishment of young second-growth forests over most of the area, some of which are ready, once again, for harvesting. On the west side of the island, there has been a shorter history of timber harvesting and the forests are older.

The Arrowsmith TSA occupies only 7% of the South Island Forest District, as the majority of productive forest land is either held as TFLs or is privately owned. About 56% of the Arrowsmith TSA land base is considered productive forest land managed by the British Columbia Forest Service (approximately 112 050 hectares). Currently about 54% of the productive Crown forest land is considered available for timber harvesting (60 097 hectares), representing about 30% of the total TSA land base.

In December 1996, the chief forester established an allowable annual cut (AAC) in the Arrowsmith TSA of 400 000 cubic metres, a decrease of 17% from the previous level. This AAC was partitioned as follows: 380 000 cubic metres for the part outside the area covered by the Clayoquot Sound Land Use Decision and 13 700 cubic metres for the part inside the area covered by the Decision, and 6300 cubic metres for alder-leading stands. The AAC is apportioned by the Minister of Forests to various licences.

As a result of the 1994 Vancouver Island Land Use Plan, more than 46 new parks were created and 81% of the Crown lands and private managed forest lands have been established as part of the Forest Land Reserve. New protected areas within the Arrowsmith TSA include the Bowser Ecological Reserve, the Ladysmith Bog Ecological Reserve, and Stamp River/Money's Pool Provincial Park. As these areas have now been formally designated, they were not included in the timber harvesting land base*.

The provincial government announced the Clayoquot Sound Land Use Decision on April 13, 1993. The area affected is about 262 000 hectares including portions of the Arrowsmith TSA. This decision increased protected areas and also established special management areas and general integrated management areas. The protected areas have now been formally designated and those located in the Arrowsmith TSA were removed from the timber harvesting land base.

Timber harvesting land base
Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.

1 Description of the Arrowsmith Timber Supply Area

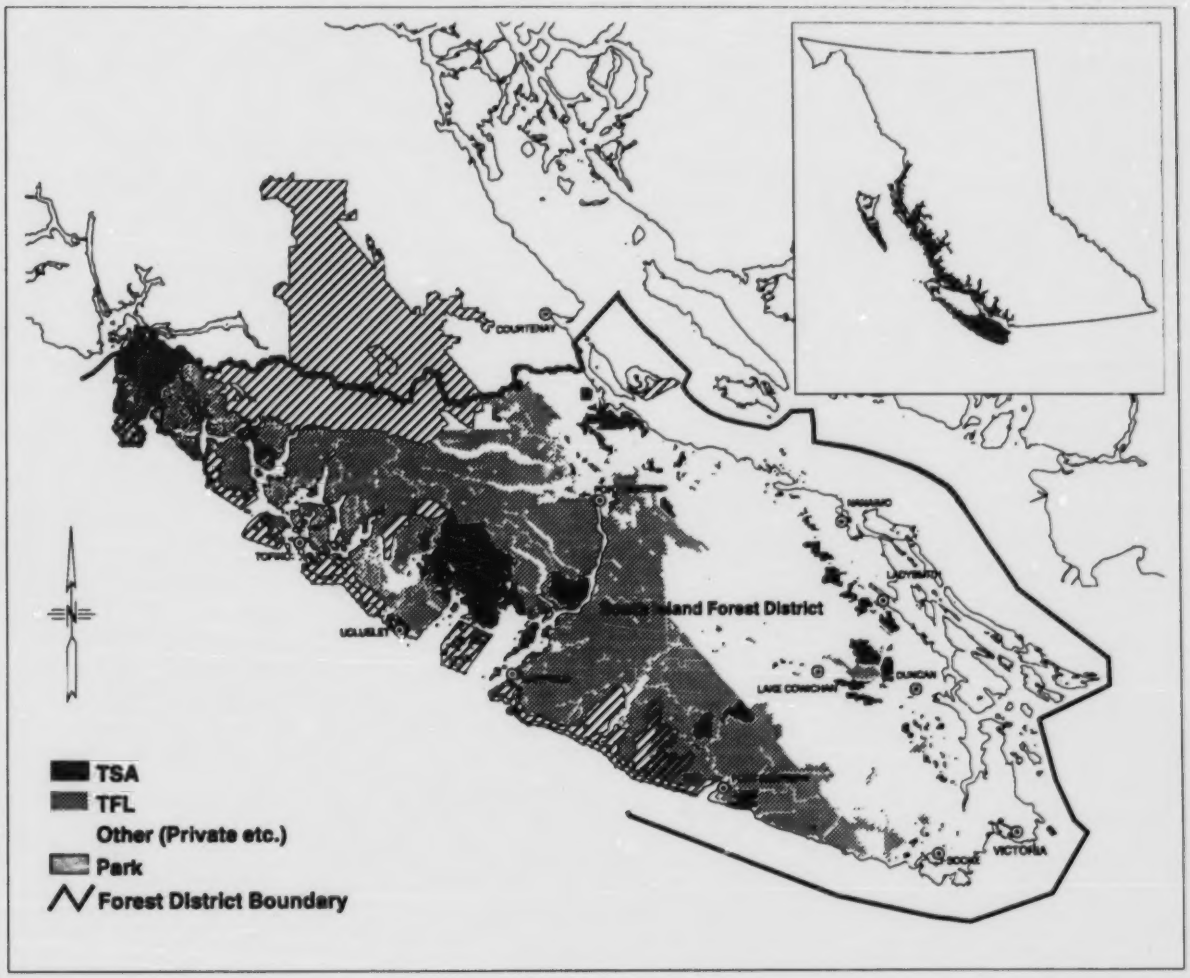

Figure 1. Map of the Arrowsmith Timber Supply Area, Vancouver Forest Region.

1 Description of the Arrowsmith Timber Supply Area

Significant changes that influence forest management have occurred since the last timber supply review was completed. These changes include:

- implementation of the *Forest Practices Code* (FPC)*;
- implementation the Vancouver Island Summary Land Use Plan; and
- inclusion of the Clayoquot Sound Land Use Decision in the timber supply analysis, rather than modelling it separately as was done previously.

Numerous natural resources are associated with the forest land base in the Arrowsmith TSA. These include forest products, recreation and tourism amenities and wildlife habitat. The mountainous terrain, marine shorelines, and numerous lakes and rivers provide a wide range of recreational and tourism opportunities including wildlife viewing, sport fishing, boating, hiking, camping, mountain-biking, trail riding and beach combing. The majority of the TSA is easily accessible to local residents as well as to visitors from other areas.

1.1 The environment

Most of the forested lands within the Arrowsmith TSA lie within one biogeoclimatic zone*, the Coastal Western Hemlock (CWH) zone, one of the most productive forest ecosystem in Canada. The CWH zone occurs at low to middle elevations and has the highest precipitation of any zone in British Columbia, with cool summers and mild winters. Western hemlock is the most common tree species in this zone, but western redcedar, Sitka spruce, yellow cedar, amabilis fir, mountain hemlock, shore pine, maple and red alder also occur, depending on local conditions and the history of disturbance.

The Coastal Douglas-fir (CDF) zone has a limited occurrence at very low elevations in the eastern part of the TSA, lying in the rainshadow of the Vancouver Island and Olympic mountains. The CDF zone is characterized by warm, dry summers and mild, wet winters. The majority of forests found today in this zone have regenerated after logging that occurred at the turn of the last century and consist of Douglas-fir often accompanied by western redcedar, grand fir, arbutus and Garry oak.

The Mountain Hemlock (MH) zone occurs at elevations above the CWH zone. It is characterized by short, cool summers and long, cool, wet winters with heavy snow cover for several months. The deep snowpack is slow to disappear, resulting in a short growing season. Mountain hemlock is the most common tree species; others include amabilis fir, yellow cedar, western hemlock, western redcedar, Douglas-fir and western white pine. At higher elevations the forest becomes discontinuous and interspersed with alpine tundra.

The Alpine Tundra (AT) zone occurs on only a few high ridges in the Arrowsmith TSA, above the MH zone. The climate is cold, windy and snowy with a short, cool growing season. By definition this zone is treeless and vegetation is dominated by shrubs, herbs, mosses and lichens. Much of the alpine landscape lacks vegetation and is the domain of rock, ice and snow.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

1 Description of the Arrowsmith Timber Supply Area

The forests within the Arrowsmith TSA are some of the most productive in Canada. The best growing sites will produce as much as 10 cubic metres of wood per hectare per year. Over time, these forests have provided the necessary products for the refinement of cultures and the growth and prosperity of society. In the past, the forest provided the raw materials to First Nations people for the production of many traditional products, from canoes and long houses to fishing nets and clothing. Today these forests provide wood fibre for the production of a variety of products, ranging from pulp and paper to value-added items such as furniture.

In addition, the Arrowsmith TSA is within an area that contains one of the richest and most diverse arrays of wildlife in Canada. Native mammals include black-tailed deer, Roosevelt elk, black bear, wolf, Vancouver Island marmot, beaver, pine marten, wolverine, short-tailed weasel, and several other furbearing species. Native and migratory birds include two threatened or endangered species (marbled murrelet and Queen Charlotte Islands subspecies of the northern goshawk) and others of management concern such as the great blue heron and pileated woodpeckers. Adjacent marine and estuary habitats support populations of Peal's peregrine falcons, bald eagles, trumpeter swans and harlequin ducks.

The coastal areas of southern Vancouver Island support substantial migrating stocks of several salmon species including sockeye, pink, coho, chum and, to a lesser extent, chinook. Barkley Sound and Alberni Inlet, which lie adjacent to a large block of the TSA, are areas of concentrated fishing, particularly sport fishing. Steelhead and cut-throat trout inhabit freshwater systems.

Under the *Forest Practices Code*, a process exists for identifying species at risk and designating wildlife habitat areas with specific management practices. Within *Volume 1* of the *Identified Wildlife Management Strategy*, six species have been identified as occurring within the five ecosections of the South Island Forest District. These species are presented in Table 1. In addition, a plant community is also identified in this table.

Table 1. Species at risk as listed under the Forest Practices Code

Common names of identified wildlife	Ecosection				
	Windward Island Mtns.	Leeward Island Mtns.	Nanaimo Lowland	Southern Gulf Islands	Strait of Georgia
American bittern		X	X		
Northern goshawk *laingi*	X	X	X		
Marbled murrelet	X	X	X	X	X
Cassin's auklet	X				
Keen's long-eared myotis	X	X	X	X	X
Vancouver Island marmot		X			
Douglas-fir/Garry oak/oniongrass		X	X	X	

Source: Managing Identified Wildlife: Procedures and Measures. Volume 1. February 1999.

Managing forested viewscapes along both land and marine travel corridors is an important management objective in this TSA, as is protection of water quality and quantity. Significant demands are placed on water resources for domestic and agricultural purposes, as well as maintenance of fisheries values and aquatic ecosystems. There are currently 10 community watersheds within the Arrowsmith TSA.

1.2 First Nations

Twenty-nine First Nations with reserves or traditional territories are located in the Arrowsmith TSA. All but three First Nations are represented by the following four tribal councils and three treaty associations: the Alliance Tribal Council; the First Nation South Island Tribal Council; the Mid-Island Tribal Council; the Nuu-chah-nulth Tribal Council; the Hul'qumi'nun Treaty Group; the Te'Mexw Treaty Association; and the Kwakiutl Laich-kwil Tach Nations Treaty Society. Some of these First Nations have entered into land claims negotiations under the British Columbia Treaty Process.

In March 1994, a two-year Interim Measures Agreement between the provincial government and hereditary chiefs of the Nuu-chah-nulth Central Region Tribes was signed. The agreement established the Clayoquot Sound Central Region board, a joint management process between First Nations and provincial government appointees. The board was established to oversee development in Clayoquot Sound, including implementation of the Clayoquot Sound Land Use Decision and the recommendations of the Scientific Panel. In April 1996, the agreement was extended for a three-year period and in March 2000, a new five-year extension agreement was signed.

In general, First Nations are becoming more active in the management of public forest lands and timber harvesting in their traditional territories. While direct involvement in TSA-based forestry activities by many First Nations has been limited, some First Nations members are employed in logging, silviculture and sawmilling. A few First Nations have been awarded forest licences and others are working in joint venture arrangements with non-aboriginal timber companies.

An archaeological overview assessment (AOA) has been completed for the Arrowsmith TSA and traditional use studies have been undertaken. Numerous archaeological sites exist within the Arrowsmith TSA and archaeological impact assessments are normally undertaken if recommended by an archaeologist as part of forest development planning.

2 Information Preparation for the Timber Supply Analysis

Timber supply analysis requires three general categories of information: land base inventory; timber growth and yield; and management practices. These three categories are discussed below. Also, in preparation for the analysis, a number of changes since the 1996 Arrowsmith TSA timber supply analysis were noted, and are described in Section 2.4.

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 2000 by the British Columbia Forest Service. This file contains information on the forest land in the Arrowsmith TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other characteristics such as environmental sensitivity and physical accessibility (operability). Stand attributes such as tree height, stocking* and age have been projected to January 2000. The inventory file has been updated to account for timber harvesting up to 1999.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development. A description of these areas specific to the Arrowsmith TSA is provided below. These types of areas do not contribute to the timber harvesting land base of the Arrowsmith TSA. Before assessing timber supply, these non-contributing areas are identified and separated from the timber harvesting land base. When deriving this data file, care is taken to make only a single reduction for areas that overlap (for example, where an inoperable area is also wildlife habitat).

Identifying areas as not contributing to timber supply does not mean the area is removed from the Arrowsmith TSA. The British Columbia Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described here is consistent with this philosophy.

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain accessible timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

For the Arrowsmith TSA, the following types of areas were excluded from the timber harvesting land base.

- not managed by the British Columbia Forest Service — these are non-Crown areas, such as private land and Indian Reserves, and parks removed from the productive forest. Parks and ecological reserves contribute towards biodiversity values.
- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.

Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

- inoperable areas — areas classified as unavailable for harvest for terrain-related reasons. Characteristics used to define operability include slope, topography (e.g., presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber volume.
- Gulf Islands – in the Southern Gulf Islands, the volume of timber harvested on Crown lands has historically been next to nil. Due to the adjacency of these Crown lands to communities, private lots and recreational properties, forest development plans are seldom approved. These areas have been removed from the timber harvesting land base.
- environmentally sensitive areas (ESA) — areas with sensitive soils, recreation values, and avalanche hazards were wholly or partially excluded.
- sites with low timber productivity — areas occupied by forest with low timber-growing potential.
- non-merchantable forest types* — stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability.
- archaeological sites — sites often adjacent to salt water and rivers with archaeologically sensitive sites (e.g., culturally modified trees, middens).
- sample plots — areas of productive forest with active growth and yield installations.
- Camper Creek — a Weyerhaeuser timber licence that will revert to Timberwest and not to the TSA, as part of a land compensation following creation of new parks.
- woodlots and community forests — areas of productive forest that have been removed from the TSA for the creation of woodlot and community forest licences.
- ungulate winter range (UWR) — areas of timber with appropriate characteristics and sufficient size to provide for the safe over-wintering and survival of ungulates.
- existing roads, trails and landings (RTL) — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- riparian reserve and riparian management zone area — area fully or proportionally unavailable for harvesting to provide protection for riparian and stream ecosystems.
- wildlife tree patch (WTP) areas — areas for the maintenance of stand-level biodiversity (stand structure), primarily for conservation or enhancement of wildlife. For the analysis, these areas were represented as reductions to the land base.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base.

The current timber harvesting land base in the Arrowsmith TSA represents about 3.7% of the total district area and about 53.6% of the productive forest within the TSA. Most of the excluded area is in three categories: inoperable areas (21.3% of the productive forest), unstable soils (8.2%) and low sites (6.5%). The remaining categories, such as riparian areas*, represent 10.4% of the productive forest. The percentages provided depend on the order in which each category is considered. For instance, riparian areas would constitute a larger proportion of the reduction if they were considered prior to inoperable areas.

Non-merchantable forest types
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Table 2. Determination of the timber harvesting land base for the Arrowsmith TSA

Classification	Area (hectares)	Per cent (%) of total area	Per cent (%) of Crown forest area
Total area in South Island Forest District	1 574 719	100.0	
Not managed by British Columbia Forest Service	1 372 882	87.2	
Non-forest	85 936	5.4	
Woodlots	331	0.0	
Bamfield community forest	439	0.0	
Camper Creek	1 612	0.1	
Existing roads	1 469	0.1	
Total productive forest land	112 050[a]	7.1	100.0
Non-commercial brush	27	0.0	0.0
Inoperable	23 859	1.5	21.3
Gulf Islands	525	0.0	0.5
Sites with low timber growing potential and non-merchantable stands	7 278	0.5	6.5
Archaeological sites	137	0.0	0.1
Sample plots	1	0.0	0.0
Avalanche hazards	139	0.0	0.1
Unstable soils	9 154	0.6	8.2
Ungulate winter range (UWR)	1 156	0.1	1.0
Recreation	2 175	0.1	1.9
Riparian	5 953	0.4	5.3
Wildlife tree patches (WTP)	1 549	0.1	1.4
Total current reductions	51 953	96.2	46.4
Initial timber harvesting land base[b]	60 097	3.8	53.6
Future roads	1 381	0.1	
Future timber harvesting land base	58 716	3.7	

(a) The total Crown forested land base in the Arrowsmith analysis area, which includes some protected areas not managed by the British Columbia Forest Service, is approximately 127 842 hectares. Although this area is not managed for timber supply, the forest contributes to non-timber objectives such requirements for old-seral forest to maintain biodiversity.

(b) The initial timber harvesting land base includes 653 hectares of unreverted and/or unlogged timber licences.

Figure 2 represents both the total South Island Forest District area, and the productive forest land base. The total area chart shows that about 87.2% of the total land base is classified as not managed by the British Columbia Forest Service, and 5.4% is classified as non-forest or non-productive forest (i.e., having very few trees). The productive forest chart details the categories of forest land within the Arrowsmith TSA and shows that about 53.6% of the forest land in the Arrowsmith TSA is considered to be available for timber harvesting (including not satisfactorily restocked (NSR)*).

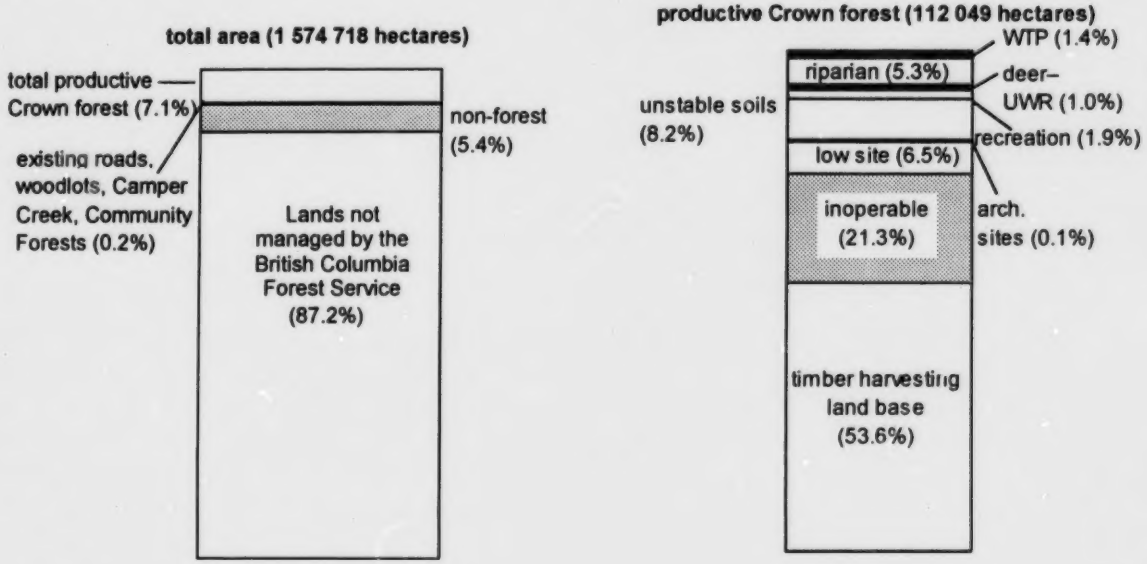
total area (1 574 718 hectares)
total productive Crown forest (7.1%)
existing roads, woodlots, Camper Creek, Community Forests (0.2%)
non-forest (5.4%)
Lands not managed by the British Columbia Forest Service (87.2%)
productive Crown forest (112 049 hectares)
unstable soils (8.2%)
riparian (5.3%)
low site (6.5%)
inoperable (21.3%)
timber harvesting land base (53.6%)
WTP (1.4%)
deer–UWR (1.0%)
recreation (1.9%)
arch. sites (0.1%)

Figure 2. Composition of the total and productive forest land bases — Arrowsmith TSA, 2001.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the current composition of the productive forest land base by dominant tree species. Redcedar dominates 36.3% of the area of stands within the productive forest land base. Hemlock/balsam (true fir) sites dominate 32.8% of the productive forest and Douglas-fir dominate 26.5%. Stands leading in alder, spruce, and other species make up the remaining portions of the productive forest.

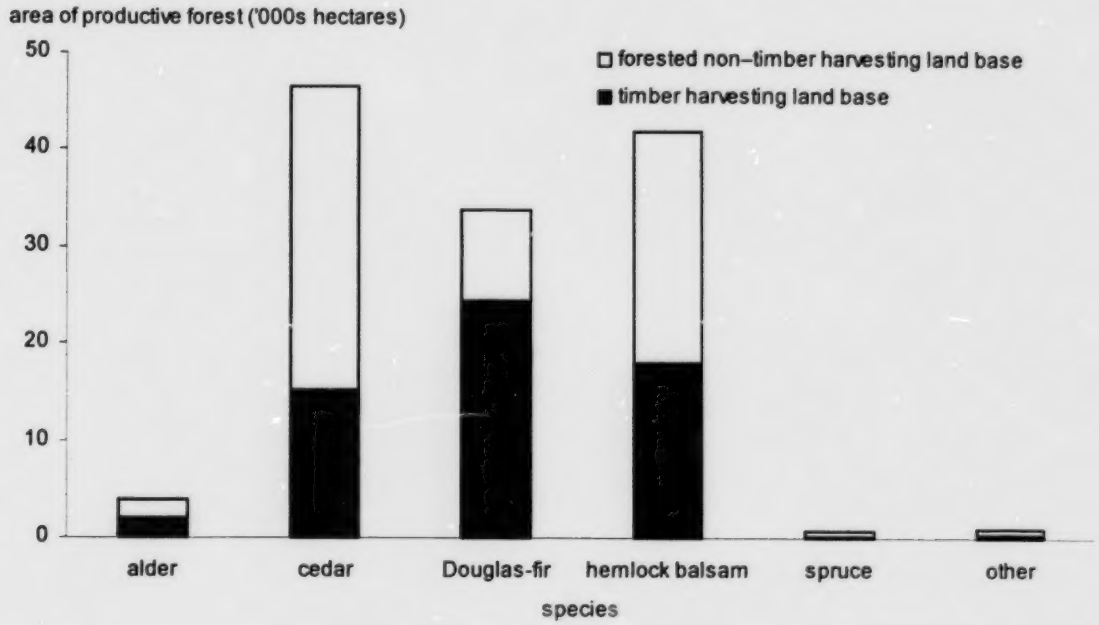

Figure 3. Area by dominant species — Arrowsmith TSA productive forest land base, 2001.

Also shown in Figure 3 is the area within the timber harvesting land base for the Arrowsmith TSA. Douglas-fir is the dominant species in the timber harvesting land base with 40.6%, followed by hemlock/balsam with 29.8% of the stands in the timber harvesting land base and redcedar with 25.3%. Douglas-fir dominates the timber harvesting land base since it occurs primarily on the drier east coast of Vancouver Island, where the land base is more operable. On the wetter west coast where most of the redcedar and hemlock/balsam stands occur, the terrain is steeper and therefore less operable for timber harvesting.

After harvest, most stands are expected to be regenerated to stands as described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

2 Information Preparation for the Timber Supply Analysis

Figure 4 provides an overview of the distribution of site productivity of the dominant stand types within the timber harvesting land base. The site classes in Figure 4 are groupings of site index* (metres in height at age 50 years). The 'poor' site class comprises 42.3% of the timber harvesting land base, while stands with a site class value of 'medium' (only Douglas-fir leading stands were given a 'medium' classification) occupy 17.4% of the area. Those stands with a site class value of 'good' (good and medium are grouped together as good for redcedar, hemlock/balsam and spruce), cover 40.4% of the timber harvesting land base. The area-weighted average site index for the timber harvesting land base is 22.8. For stands older than 140 years of age, the area-weighted average site index is 15.7.

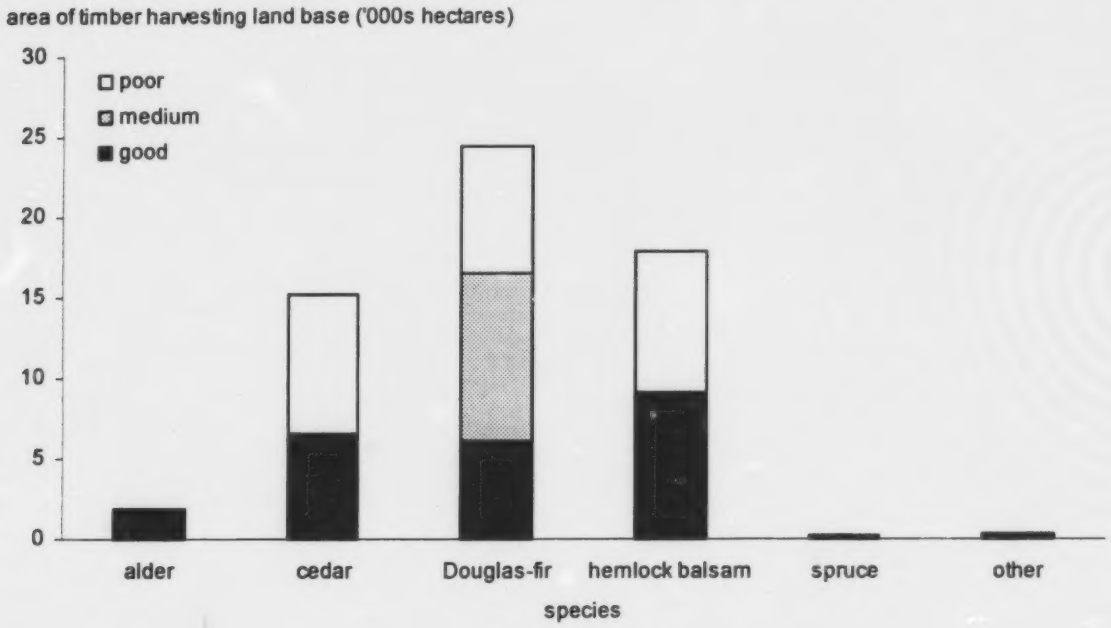

Figure 4. Area by species and site class — Arrowsmith TSA timber harvesting land base, 2001.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age composition of forested stands in the Arrowsmith TSA. About 19% of the timber harvesting land base is occupied by stands older than 250 years. About 18% of the area is covered with stands 20 years or younger, 53% is between 21 and 100 years old, and 10% is between 101 and 250 years of age. Almost 59% of the timber harvesting land base is covered with stands at or above the minimum harvestable age applicable to the stand.

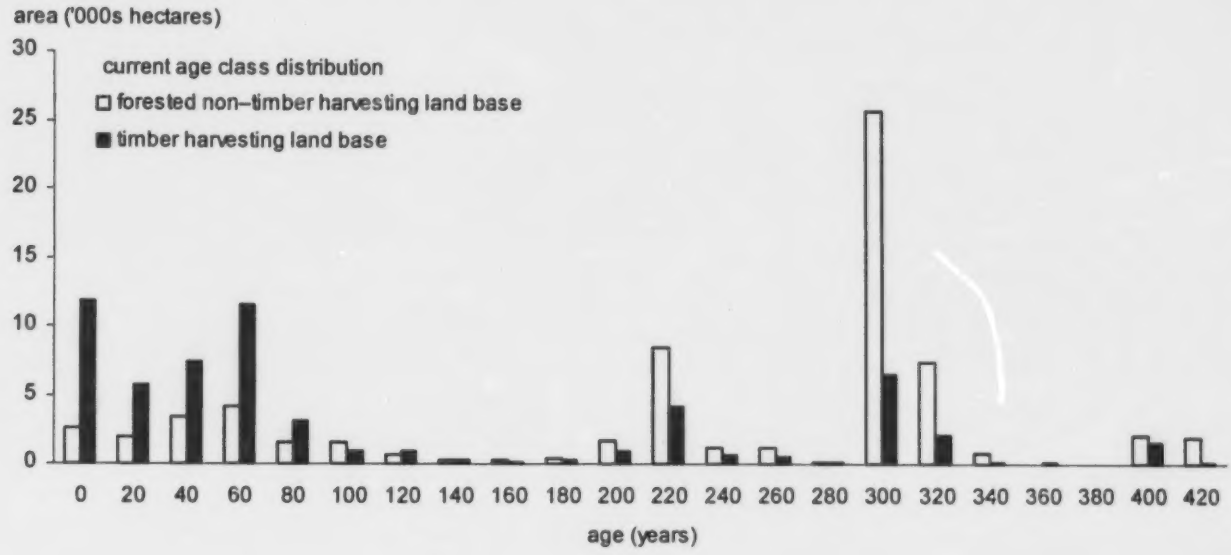

Figure 5. Current age class composition — Arrowsmith TSA productive forest land base, 2001.

The age class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. Although they do not contribute directly to timber supply, these areas can affect how much harvesting can be conducted and the pattern of the harvesting within the TSA by providing old-forest and biodiversity attributes. The total Crown forested land base in the Arrowsmith analysis area, which includes some land not managed by the British Columbia Forest Service, is approximately 128 000 hectares. A significant portion of the total forest area — 53% — does not contribute to the timber harvesting land base. About 59% of these "non-timber harvesting land base" stands are currently older than 250 years and therefore can potentially meet biodiversity requirements.

In the longer term, the non-timber harvesting land base will be able to provide much of the area needed to meet old-forest biodiversity requirements as set out in the *Landscape Unit Planning Guide* (LUPG). However, some old-forest timber harvesting land base will have to be reserved from harvesting into the medium-term while forests in the non-timber harvesting land base age sufficiently to achieve old-forest conditions. This is particularly true of the drier east coast biogeoclimatic subzones where harvesting history has all but eliminated old growth in some cases and there is very little non-timber harvesting land base to rely upon for recruitment of old growth.

2 Information Preparation for the Timber Supply Analysis

2.2 Timber growth and yield

Two growth and yield models were used to estimate timber volumes for the Arrowsmith TSA analysis. The variable density yield prediction (VDYP) model developed by the British Columbia Forest Service, Resources Inventory Branch, was used for estimating volumes in unmanaged coniferous and deciduous* stands. Managed deciduous stand volumes were also assigned using VDYP volume estimates*. The table interpolation program for stand yields (TIPSY), developed by the British Columbia Forest Service, Research Branch, was used to estimate yields for coniferous managed stands. TIPSY was also used to estimate yields from stands that were harvested in the past but managed to current standards. Depending on the species, these stands may be as old as 50 years of age.

Timber volume estimates assume a specific utilization level which establish the minimum tree and log sizes that are removed from a site. Utilization levels specify minimum diameters both near the base and the top of a tree as well as a maximum stump height.

Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains details on the definition of managed stands, utilization standards and the specific model versions used.

Volume estimation and prediction are subject to uncertainty due to uncertainties in inventories which form the basis for estimating site productivity, limited experience with second-growth in British Columbia, and the long-time frame over which trees grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates, the current timber inventory on the timber harvesting land base is approximately 19.0 million cubic metres. About 17.7 million cubic metres, or 93%, of the total, is currently merchantable; that is, older than minimum harvestable age.

2.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis. The *Forest Practices Code of British Columbia Act* and associated regulations guide forest management practices in the Arrowsmith TSA. The focus of the Timber Supply Review is to assess timber supply based on current management practices as implemented in plans for the area. Current management is described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis"). Staff in the South Island Forest District provided information for the following management practices:

- Silviculture — reforestation activities required to establish free-growing* stands of acceptable tree species. Use of improved seedlings is considered to be current practice in the Arrowsmith TSA. The actual amount of improved seedlings used is dependent on the available supply of improved seed, which is currently less than the demand.
- Incremental silviculture —stand thinning.
- Forest health and unsalvaged losses* — timber losses to fire, wind and pest (insect) damage. Estimated to be 2000 cubic metres annually, on average.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.

Deciduous
Deciduous trees shed their leaves annually and commonly have broad-leaves.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.

- Minimum harvestable ages (MHA) — the time it takes for stands to grow to a merchantable condition. These were based on district priorities, product, age-volume yield tables and input from local forest industry representatives. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other available stands, forest cover objectives and overall timber harvest targets.
- Cutblock adjacency* and green-up* — in the Arrowsmith TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (3 metres in height for integrated forest management area and 5 metres in height for visual quality management areas), before adjacent stands may be harvested. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time. These guidelines were modelled by limiting the area within the integrated resource management (IRM)* zones that does not meet green-up conditions to a maximum of 25%.
- Ungulate winter range (UWR) — to provide ungulates with acceptable winter cover and forage, identified stands were removed from the timber harvesting land base to provide critical winter ranges.
- Protection of environmentally sensitive areas* (ESA) where hazardous terrain, sensitive soils, recreation values, and avalanche hazards have been identified. To maintain ecological or other resource values, land has been wholly or partially removed from the timber harvesting land base.
- Community watersheds — within designated watersheds a maximum of 1% of the forest area may be cut over in any one year. This represents a maximum of 5%/5 year period for modelling purposes. Community watersheds cover 3880 hectares, or 6.4% of the timber harvesting land base.
- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting be kept within limits in designated areas of the Arrowsmith TSA. The maximum proportion of the total forest in each scenic area that may be covered by young stands that do not meet visual green-up requirements varies depending on the forest characteristics, and the visual quality objectives (VQO) for each area, ranging between 3% and 25%.
- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit*, the *Forest Practices Code* contains targets for the proportion of the area in each biogeoclimatic variant that should be covered by stands with old-forest characteristics. Within the Arrowsmith TSA, old-forest is characterized by stands greater than 250 years old in natural disturbance types (NDT) 1 and 2. The implementation of the Vancouver Island Summary Land Use Plan directs Landscape Unit Planning in the South Island Forest District, therefore the actual biodiversity* emphasis options (BEO) for each landscape unit are applied to draft landscape units.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Landscape-level biodiversity
The Landscape Unit Planning Guide provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.

- Fragmentation — on the east coast of Vancouver Island, significant portions of the Arrowsmith TSA are small and surrounded by private land or adjacent to communities. Access for harvesting in these areas is difficult and constrained. To reflect this difficulty of access in these areas, the fragmented areas are modelled similar to a partial retention VQO, requiring a maximum of 10% less than a 5 metre green-up height. The fragmented land base covers 3472 hectares (5.8%) of timber harvesting land base, primarily on the east coast of Vancouver Island and primarily south of Nanaimo.
- Coastal watershed assessments — two key watersheds in the Arrowsmith TSA have been subject to Coastal Watershed Assessment Plans (CWAP) that limit the amount of future timber harvesting to allow for hydrological green-up. In the Gordon Watershed, a constraint of a maximum of 24% of the productive forest can be less than 9 metres green-up. In the south basin of the Escalante, a maximum of 165 hectares can be harvested over the next 8 years.
- Vancouver Island Summary Land Use Plan — in 2000 the Vancouver Island Summary Land Use Plan was endorsed by government, followed by a higher level plan order that implements the specific sections of the plan under the *Forest Practices Code*. In this analysis, two considerations have been taken into account. In Enhanced Forestry Zones, a 1.3 metre green-up height for cutblock adjacency has been modelled. In Special Management Zones, a minimum of 25% of the forest is to be retained as mature forest (generally 80 years old in most cases).
- Clayoquot Sound — the *Clayoquot Sound Scientific Panel Report* made recommendations that affect the rate of timber harvest in watersheds and sub basins in Clayoquot Sound. Within each watershed sub-basin, a minimum of 40% of the productive forest must be greater than 140 years old. A maximum rate of harvest of 1% of the timber harvesting land base in each sub-basin is permitted to be harvested each year. Clayoquot Sound covers 10% of the timber harvesting land base in the Arrowsmith TSA.
- Harvest systems — clearcut with reserves, commercial thinning*, and retention harvesting are performed in the Arrowsmith TSA.
- Retention harvesting — major Forest licensees and the Small Business Forest Enterprises Program (SBFEP) have made commitments to increase the amount of retention harvesting in the Arrowsmith TSA. Retention harvesting is a system that is designed to retain individual trees or groups of trees to maintain structural diversity over the area of the cutblock* for at least one rotation. Since additional trees are maintained in the each cutblock, a 4.25% volume reduction has been used to model retention systems in the base case.

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Commercial thinning
A silviculture treatment that 'thins' out an overstocked stand by removing trees that are large enough to be sold as products such as poles or fence posts (see also, Juvenile spacing). It is carried out to improve the health and growth rate of the remaining crop trees.
Cutblock
A specific area, with defined boundaries, authorized for harvest.

2 Information Preparation for the Timber Supply Analysis

The data package for the Arrowsmith Timber Supply Area (TSA) was released in May 2000. As a result of public input and new information coming to light, changes were required to the data package. The revised data package, which includes detailed descriptions of the management practices and the assumptions used to incorporate them into the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" of this document.

Figure 6 shows the proportions of the forested land base and the timber harvesting land base subject to management for scenic values, community watershed considerations, fragmentation, Coastal Watershed Assessments, Vancouver Island Summary Land Use Plan and Clayoquot Sound. Often several management objectives are applied to the same area; for example, all or part of a visual quality area may also be managed as a community watershed. In such a case, the area is required to meet all of the management objectives. The bar charts show the total area in each management emphasis area.

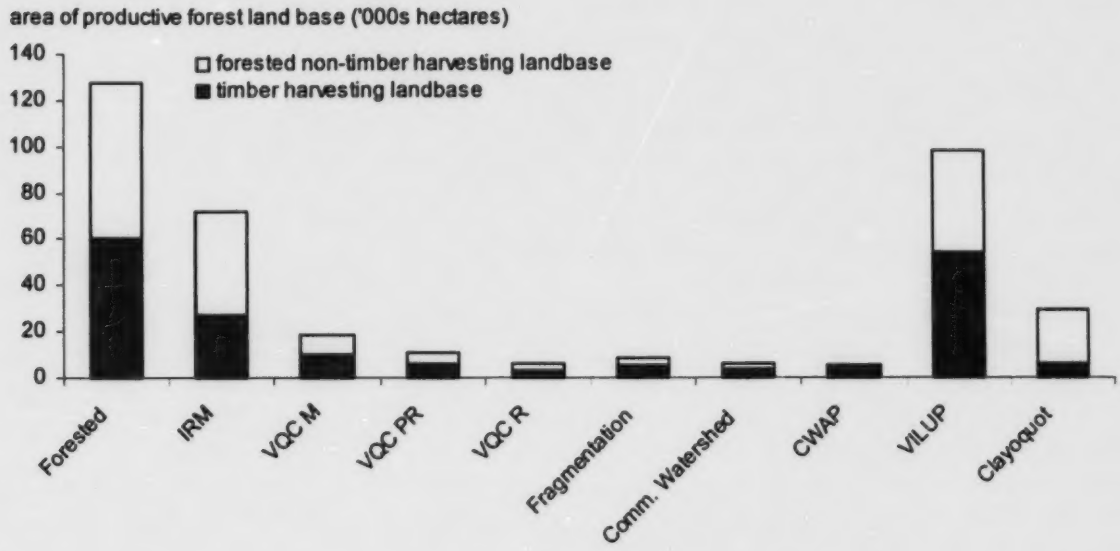

Figure 6. Forest management zones — Arrowsmith TSA forested land base, 2001.

Figure 7 shows the distribution of the land base by biogeoclimatic (BEC) variant*. Also shown is the proportion of the total forest area in each BEC variant that is part of the timber harvesting land base. Table 3 provides a summary by BEC variant, indicating the composition of the total forest area and of the timber harvesting land base by BEC variant, and also showing the proportion of the total variant forest area that is within the timber harvesting land base. This latter provides indication of the likelihood that forest outside the timber harvesting land base will be sufficient to meet old-seral requirements.

The table shows that for the variants that make up most of the forest area (CWH vm1, CWH xm1 and CWH xm2), 57%, 22% and 25% respectively of the total forest is outside the timber harvesting land base. In the wetter west coast variants (vm1), there is likely sufficient forest outside of the timber harvesting land base to provide for old-growth management areas (OGMA). In the dry east coast variants (xm1 and xm2) the amount of area outside the timber harvesting land base is relatively small and is likely insufficient to meet old-seral requirements in some landscape units.

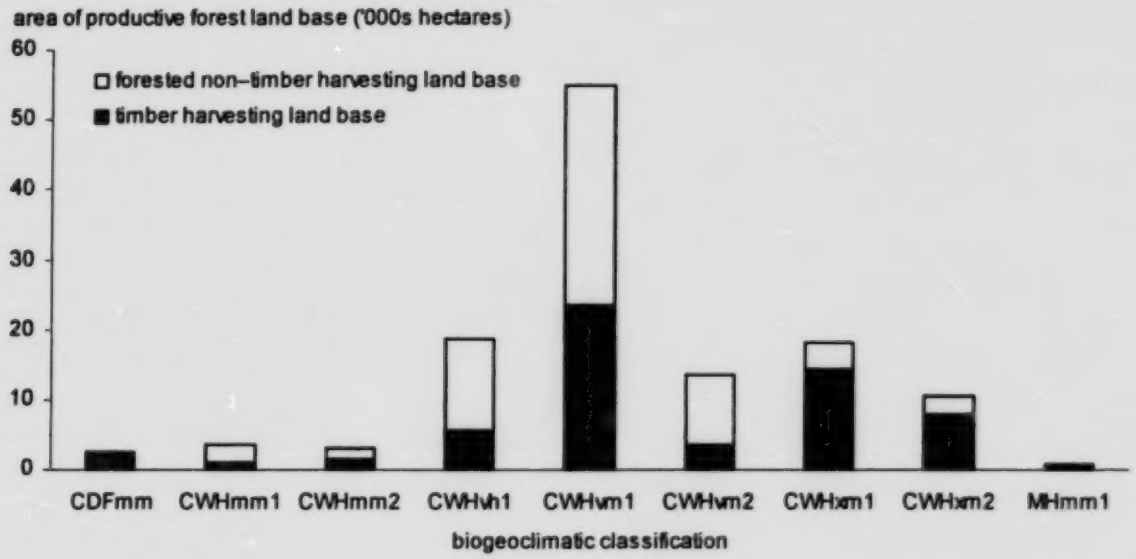

Figure 7. Area by biogeoclimatic classification — Arrowsmith TSA, 2001.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

Table 3. Summary of biogeoclimatic zone areas — Arrowsmith TSA, 2001

Biogeoclimatic ecosystem classification (BEC) zone	Per cent (%) of total forest area in BEC zone	Per cent (%) of timber harvesting land base in BEC zone	Per cent (%) of total BEC zone area in timber harvesting land base
CDF mm	2.0	4.2	100.0
CWH mm1	2.8	1.7	28.4
CWH mm2	2.3	2.6	52.2
CWH vh1	14.9	9.1	29.4
CWH vm1	43.6	39.1	42.9
CWH vm2	10.9	6.1	26.8
CWH xm1	14.5	23.7	78.2
CWH xm2	8.3	13.1	75.4
MH mm1	0.6	0.5	34.4
Total	100.0	100.0	Not applicable

2.4 Changes since the 1995 Arrowsmith TSA analysis

The size and availability of the timber harvesting land base, management practices and modelling capabilities have changed since the last analysis for the Arrowsmith TSA. This section presents the major changes to the land base and forest management assumptions* since the last analysis.

- The timber harvesting land base has changed since the last analysis. In the previous analysis (1995) the initial timber harvesting land base was 68 676 hectares (net of Clayoquot and other minor adjustments). In this analysis the initial timber harvesting land base is 60 097 hectares, a decrease of 12%. Creation of several small parks as a result of the Vancouver Island Summary Land Use Plan, land exchanges for compensation and new woodlots have all removed area from the TSA. Implementation of the *Forest Practices Code* has increased land base reductions for riparian reserves and reductions for wildlife tree* patches (WTPs). Requirements to maintain or recruit suitable areas of old forest for landscape-level biodiversity also limit the availability of timber on the timber harvesting land base.
- In this analysis management requirements were applied at a finer level than was achievable in the last analysis.
- Existing road netdowns are now applied on an area-specific basis rather than as general percentage area exclusions applied against all stands.
- Since the previous analysis, the area subject to visual quality objectives (VQO) has decreased only slightly from 34% to 33% of the timber harvesting land base. Since the implementation of the VQO Buyback Strategy, the South Island Forest District was divided into three scenic zones. In zone 1, the most visually sensitive, VQO's are modelled at the midpoint of the disturbance range in this analysis. In zone 2, VQO's are modelled at the maximum of the disturbance range. In zone 3, the non-scenic area, VQO's are not modelled.
- In the 1995 analysis, Clayoquot Sound was modelled separately from the rest of the TSA as a tabular exercise. In this analysis, Clayoquot Sound has been included in the analysis, but with its own unique forest management constraints that are specific to the *Clayoquot Sound Scientific Panel Report*.
- With the creation of a forest license for red alder in the district, red alder has now been included in the timber harvesting land base for the TSA. Previously, red alder was considered unmerchantable.
- Implementation of the Vancouver Island Summary Land Use Plan has changed forest management practices in designated zones of the TSA. These management zones range from intensive forestry zones to biodiversity emphasis zones and have been modelled as such in this analysis.

In summary, the timber harvesting land base has decreased by 12% and some modelling assumptions have changed since the last analysis. Given the extent of these changes, direct comparisons between this and the previous analysis are difficult and complex. Each analysis needs to be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. As noted in the introductory section, there is uncertainty surrounding information used in analyses, and forest management objectives change over time, which is why the *Forest Act* requires the chief forester to review the timber supply and AAC for each TSA periodically.

Any changes to the land base or management assumptions that occur or become effective after the completion of this timber supply analysis will be presented to the chief forester for consideration during the AAC determination, if possible.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Arrowsmith TSA, in light of current forest management practices. A timber supply computer simulation model developed by the British Columbia Forest Service (FSSIM version 3.0) was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast* (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the British Columbia Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of green-up and old-forest prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The British Columbia Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implication of a particular management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local British Columbia Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports sustainable forest management in the field.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Arrowsmith TSA. The base case harvest forecast* uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." The impacts of uncertainty in the inputs to the analysis will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only a part of the timber supply picture for the Arrowsmith TSA, and should not be viewed in isolation of the sensitivity analysis*.

Section 2.4, "Changes since the 1995 Arrowsmith TSA analysis," provides an overview of the major changes to the land base and management assumptions since the last analysis. The conclusion of that section was that any comparison between this and the last analysis should be made with recognition of the extent and nature of those changes. Each analysis should be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. Finally, one of the major reasons the chief forester is required under the *Forest Act* to periodically review the timber supply and AAC is to account for changes in management, as well as new information.

4.1 Base case harvest forecast

The base case harvest forecast for the Arrowsmith TSA represents current management within the South Island Forest District as reflected in Appendix A of this report.

Figure 8 shows the base case harvest forecast for the Arrowsmith TSA. The initial harvest level is 357 000 cubic metres per year, which is 11% less than the current allowable annual cut of 400 000 cubic metres. The base case harvest forecast consists of 11 000 cubic metres per year from Clayoquot Sound, 6300 cubic metres per year from red alder-leading stands, and 339 700 cubic metres per year from conifer-leading stands outside Clayoquot Sound.

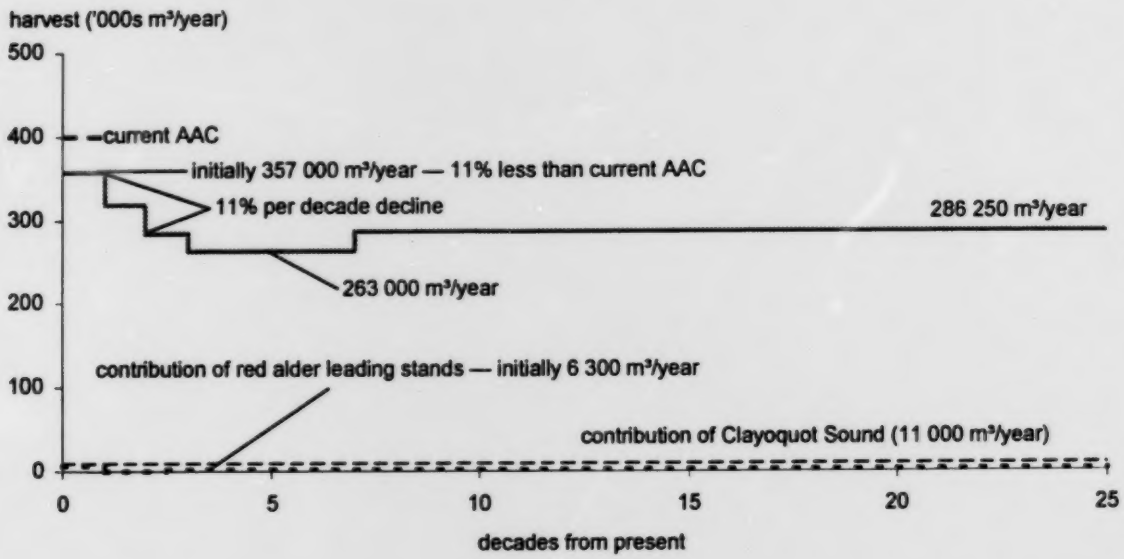

Figure 8. Base case harvest forecast for the Arrowsmith TSA, 2001.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.

4 Results

The initial harvest level of 357 000 cubic metres can be maintained for one decade before declining by 11% per decade to 263 000 cubic metres per year by the fourth decade. After 7 decades, the harvest increases by 9%, up to the long-term harvest level* of 286 250 cubic metres per year. The long-term level is 20% below the total initial harvest of 357 000 cubic metres per year, and 28% below the current AAC.

In Clayoquot Sound, the harvest forecast is arrived at using the applicable management recommendations of the *Clayoquot Sound Scientific Panel Report*. Though the *Panel Report* does not necessarily provide harvest flow recommendations, in keeping with the spirit and intent of the *Report*, a non-declining even-flow was used for the harvest forecast. The projected harvest of 11 000 cubic meters per year is 20% less than the previous Clayoquot AAC of 13 700 cubic metres. The previous Clayoquot AAC from the 1996 analysis was developed using a tabular approach that considered only the current forest cover condition of sub-basins in Clayoquot Sound. The current analysis projects the Clayoquot harvest through time and estimates the harvest based on the changing condition of each sub-basin. Applying a non-declining harvest flow can be more constraining on short-term timber supply as the flow will be held back by the most constraining period in the analysis. This is the case for Clayoquot where a point in time five decades into the future is the most constraining for the timber supply.

The harvest of red alder is influenced by the existing forest licence for red alder. The initial alder harvest forecast is 6300 cubic metres per year for the next decade. After one decade the harvest of alder drops to zero for fifteen years, and then returns to a long-term level of 3000 cubic metres per year.

Unsalvaged losses due to natural forces such as insects, wind and fire are estimated to be 2000 cubic metres per year for the entire 250-year horizon and have been subtracted from all harvest forecasts shown in this report.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

4 Results

The base case harvest forecast for the Arrowsmith TSA can be thought of as three integrated forecasts, the short-, medium-, and, long-term. The short-term harvest forecast is determined by the amount of currently existing timber growing stock*. Figure 9 shows a projection of timber inventory volumes over time corresponding to the base case harvest forecast. Total growing stock on the timber harvesting land base declines over the first 3 decades from 19 million cubic metres as the oldest of the existing mature stands are harvested and replaced by younger second-growth, to a low of 17 million cubic metres. Over the long term, the total growing stock rises to over 21 million cubic metres by the 25th decade. The average total growing stock for the base case is 19.5 million cubic metres. Merchantable growing stock is defined as that volume of timber which is of harvestable age, as defined in Appendix A. The average merchantable growing stock over the long term is 15 million cubic metres.

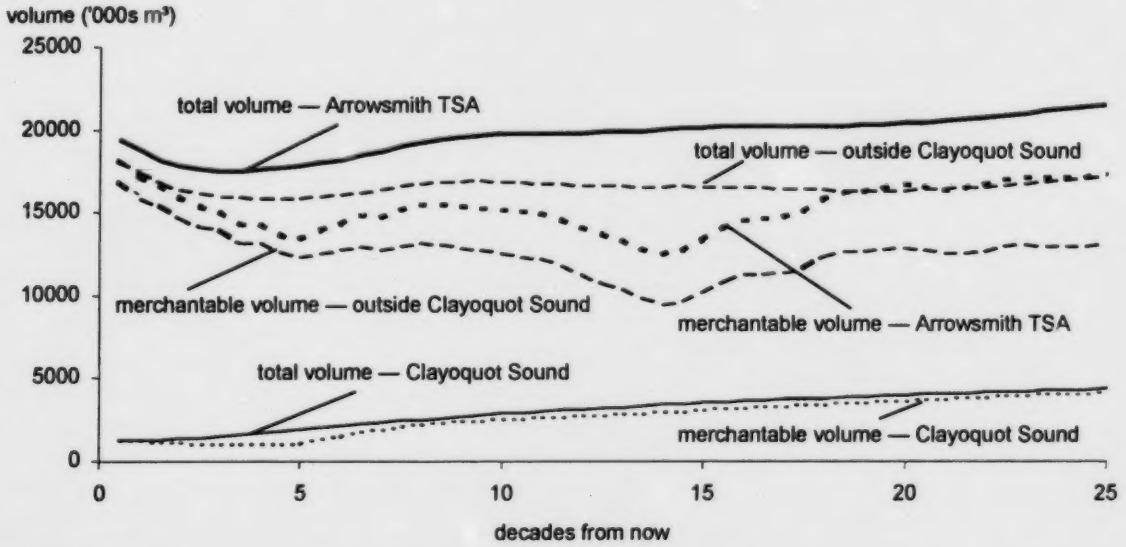

Figure 9. Total and merchantable growing stocks — Arrowsmith TSA, 2001.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

Since the harvest forecast is essentially divided between areas inside Clayoquot and outside of Clayoquot, it is important to look a the growing stock divided between these two areas. Inside Clayoquot Sound where the timber harvesting land base is heavily constrained, both the total and merchantable growing stocks are increasing through time. The merchantable growing stock in Clayoquot reaches a low of one million cubic metres in 5 decades, which corresponds with the most constrained point of the Clayoquot harvest forecast. In the area outside of Clayoquot, both the total and merchantable growing stock remain relatively constant after 25 decades. The merchantable growing stock outside of Clayoquot reaches a low of 9.5 million cubic metres in the 14th decade, or 43% below the total growing stock. This time in the future, when stand availability is low, corresponds with the most constrained point of the overall harvest forecast.

The base case long-term harvest level of 286 250 cubic metres per year is the harvest rate that can be achieved while maintaining the total timber growing stock on the timber harvesting land outside of Clayoquot base at an even level, over the long term. An even-growing stock indicates that harvesting can continue at the corresponding harvest level in perpetuity. A continually increasing growing stock would indicate that the timber is being harvested below the productive capability of the land. A continually declining growing stock would signify that the timber is being harvested above the productive capability of the land. The area outside of Clayoquot was selected to test the growing stock level since over 90% of the timber harvesting land base resides outside of Clayoquot Sound and over 96% of the long term harvest level is outside of Clayoquot.

The medium-term harvest forecast includes the transition of harvesting from existing older stands to managed future stands. Figure 10 shows the transition of harvesting from existing to managed stands, and the amount that each makes up in the base case forecast. Also shown is the contribution of old stands (stands > 250 years at time of harvest). Harvest of old stands was constrained to a maximum of 75% of the total harvest throughout the harvest forecast. This is a reflection of current practices in the Arrowsmith TSA, where most of the old harvest is coming from the west coast of Vancouver Island, accounting for about 75% of the harvest, and most of the remaining harvest currently comes from stands on the east coast of the island.

The harvest of old stands is also significant in decades 17 through 22 as shown in Figure 10. These old stands are primarily on the east coast of Vancouver Island where forest cover constraints for biodiversity require the retention of significant areas of timber harvesting land base for old-growth management areas since there is very little productive forest area outside of the timber harvesting. As the forest ages, eventually the non-timber harvesting land base becomes old, allowing some of the previously constrained timber to be harvested. In decade 18, the harvest of old stands is projected to briefly be over 100 000 cubic metres per year, all from the east coast of Vancouver Island.

4 Results

The transition of natural stand harvest to managed stand harvest begins nearly immediately in the Arrowsmith TSA. By the 7th decade, the majority of the harvest is coming from managed stands. The 7th decade is also the transition to the long-term harvest level (see Figure 8).

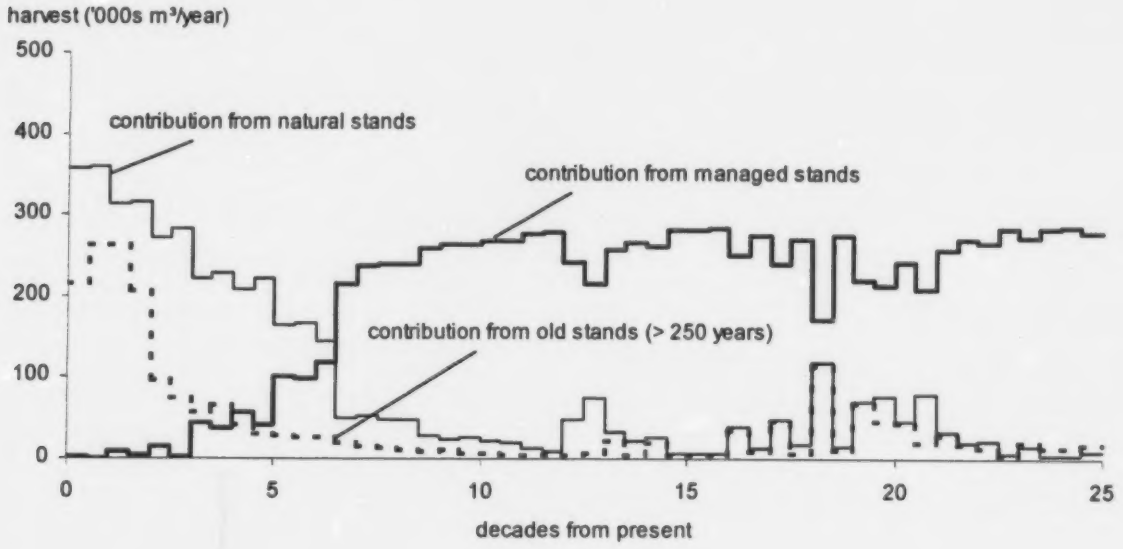

Figure 10. Harvest contribution from existing, managed, and old stands — Arrowsmith TSA, 2001.

4 Results

The average growth rate projected from regenerated stands over the long term is about 4.9 cubic metres per hectare per year (the total timber supply, including non-recoverable losses (NRL), divided by the future timber harvesting land base). As noted in Appendix A, productivity estimates vary significantly within the Arrowsmith TSA. If all stands were harvested at the age of maximum productivity, an annual growth rate of 5.6 cubic metres per hectare per year would be possible in the long term. However, the long-term harvest level is below the theoretical maximum productive capacity of the timber harvesting land base since all stands cannot be harvested at the optimum time due to other management considerations on the land base and the objective of maintaining a consistent harvest flow over time.

4.2 Area, average volume and average age harvested

Figure 11 shows the annual area harvested over the next 250 years (these areas have not been adjusted to account for the volumes deducted annually for non-recoverable losses) by clear cut, variable retention and commercial thinning harvest systems.

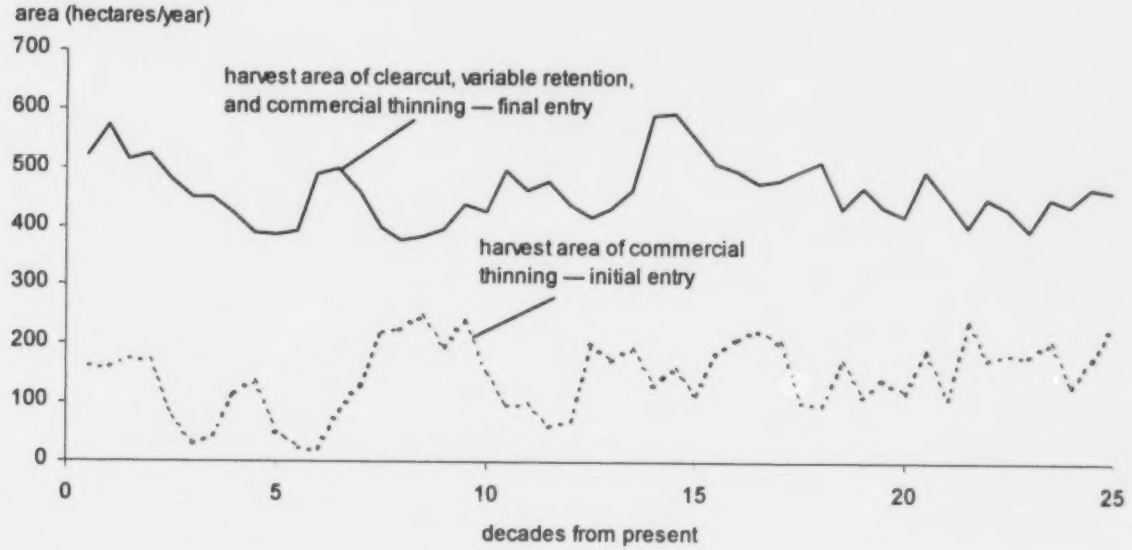

Figure 11. Average area harvested over time — Arrowsmith TSA base case, 2001.

Average area harvested begins to decline immediately as the harvest level declines over the first three decades and reaches a low of 376 hectares per year in the 8th decade. Over the long term, the average area harvested is 461 hectares per year, reaching a maximum of 595 hectares per year in the 14th decade, which corresponds with the dip in merchantable growing stock that is evident in Figure 9. Figure 11 also shows the projected harvest area of initial entries for commercial thinning in good and medium Douglas-fir stands. For the first two decades, the volume of commercial thinning is constrained to a maximum of 23 700 cubic metres per year, translating to approximately 165 hectares per year of commercial thinning. Over the long term, the area of commercial thinning is constrained to a maximum of 300 hectares per year, though the forecast never reaches this level. The maximum annual area of commercial thinning is 251 hectares in decade 8. The average area of commercial thinning over 25 decades is 147 hectares per year.

4 Results

Figure 12 tracks the change in the area-weighted harvest age resulting from the base case forecast. Initially the harvest comes from the oldest stands in the timber harvesting land base. As the old stands are depleted, the average harvest age declines steadily down to less than 100 years of age by the 6th decade. Over the long term, from the 7th decade onward, managed stands comprise more of the forecast harvest, and the average age of the harvested stands is approximately 96 years. Areas harvested by commercial thinning are represented separately in Figure 12. Over the 25 decade time horizon the projected average entry age for commercial thinning is 47 years. The young entry is also a reflection of thinning opportunity window for Douglas-fir stands. After their minimum entry age, stands have 20-year window of opportunity in which to be thinned. After this time, if the stands have not been thinned, they are too old to benefit from thinning and will instead be scheduled for clearcut or variable retention harvesting. For example, Douglas-fir on good sites can be commercially thinned only between the ages of 40 and 60.

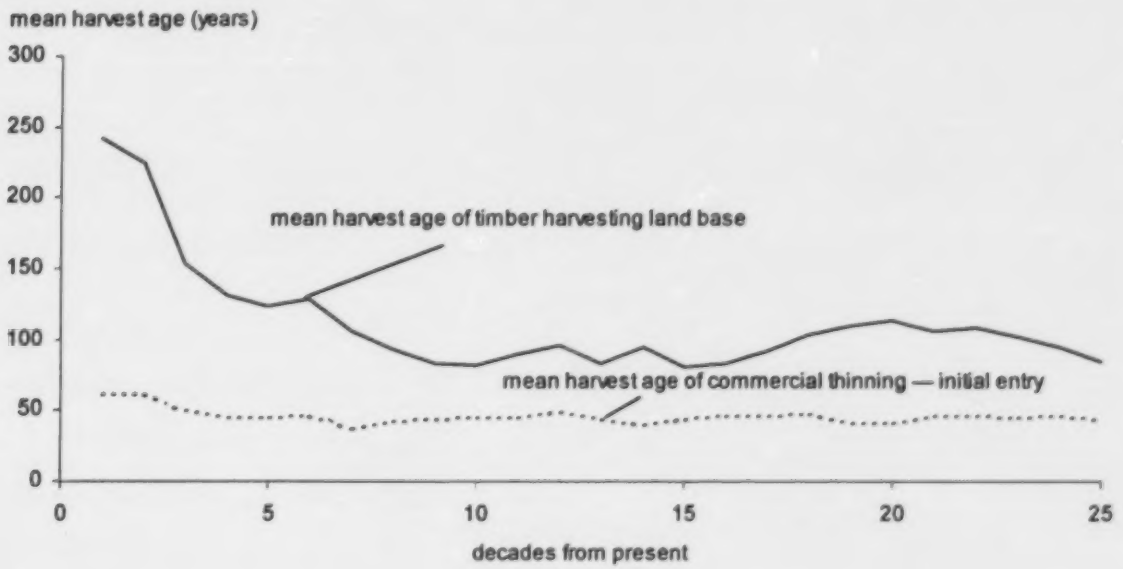

Figure 12. Average age of stands harvested over time — Arrowsmith TSA base case, 2001.

4 Results

Figure 13 shows the average timber volume harvested in the base case forecast. These average volumes were derived using the total harvested volume from either clearcut and variable retention or commercial thinning. No accounting was made for unsalvaged losses since it was not possible to adjust area harvested figures to account for the area corresponding to the losses. As shown in Figure 13, commercial thinning systems remove a much lower volume per hectare on average. Refer to Appendix A for a description of the commercial thinning management regime. The average harvest volume remains near 600 cubic metres per hectare for much of the 25 decades. The average harvest volume declines in the 19th decade to less than 500 cubic metres per hectare, corresponding with Figure 9 and the decline in merchantable growing stock. This decline in volumes is due primarily to a shortage of good and medium site stands at this time and the harvest coming primarily from poorer sites, with older harvest ages and lower volumes/hectare. The average harvest volume from commercial thinning is constant reflecting the assumptions in Appendix A that commercial thinning yields a constant volume.

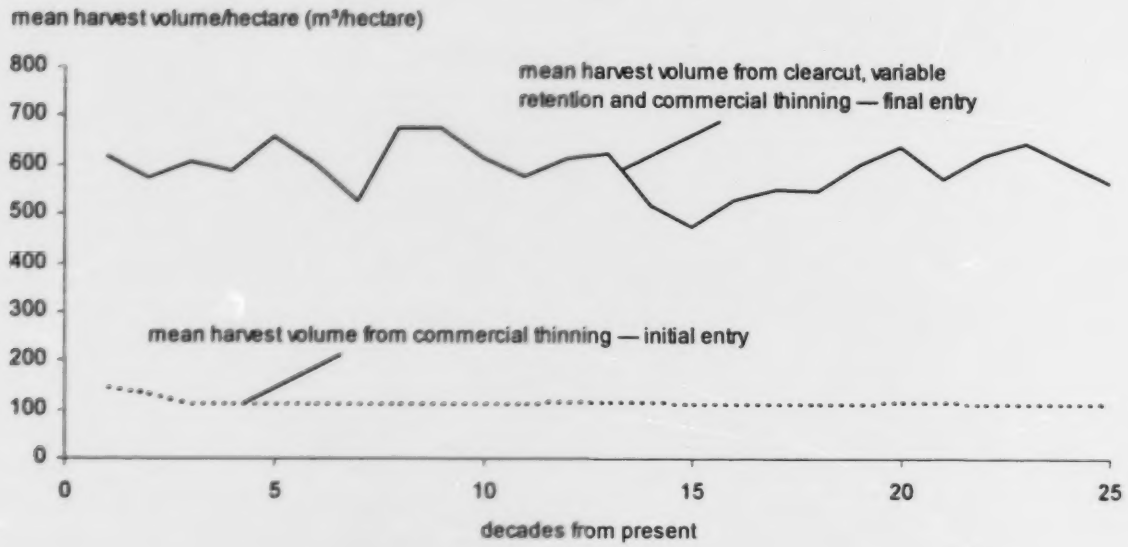

Figure 13. Average volume per hectare harvested over time — Arrowsmith TSA base case, 2001.

4.3 Age class profile over time

The charts in Figure 14 show how the age composition of the Arrowsmith TSA productive forest land base changes over the next 250 years under the base case harvest forecast.

There are approximately 127 000 hectares of productive forest land base within the Arrowsmith TSA analysis area, of which 60 097 hectares makes up the initial timber harvesting land base. The current age class distribution shows about 18% of stands within the timber harvesting land base are currently above 250 years of age and 29% are currently greater than 140 years of age.

The productive forest land base also contains stands that have been excluded from the timber harvesting land base. Outside of the timber harvesting land base, 86% of the stands are over 140 years old, though most of this is on the west coast. Almost 41% of the Arrowsmith TSA is made up of stands greater than 250 years of age, three-quarters of which are from the non-timber harvesting land base, again, primarily on the west coast of Vancouver Island.

One consequence of there being a large area (67 000 hectares) of stands outside the timber harvesting land base, is that a relatively small proportion of the timber harvesting land base needs to be reserved from harvest to meet old seral* landscape-biodiversity objectives until stands outside the timber harvesting land base age. However, since the non-timber harvesting land base is primarily on the west coast, landscape units on the east coast tend to have insufficient areas within which to meet old-seral objectives. In 100 years approximately 2400 hectares of the timber harvesting land base are forecast to be occupied by stands over 200 years of age, representing areas that are being retained and unharvested due to constraints.

To model the effects of natural disturbances on biodiversity constraints, 115 hectares per year of the non-timber harvesting land base is reverted from old seral to an early seral condition. he net effect of this ensures that not all of the non-timber harvesting land base ages through time, all becoming old seral. Presently, 42% of the non-timber harvesting land base is less than 250 years old). In the base case forecast, there is estimated to be about 45% less than 250 years old in two decades.

Old seral
Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

4 Results

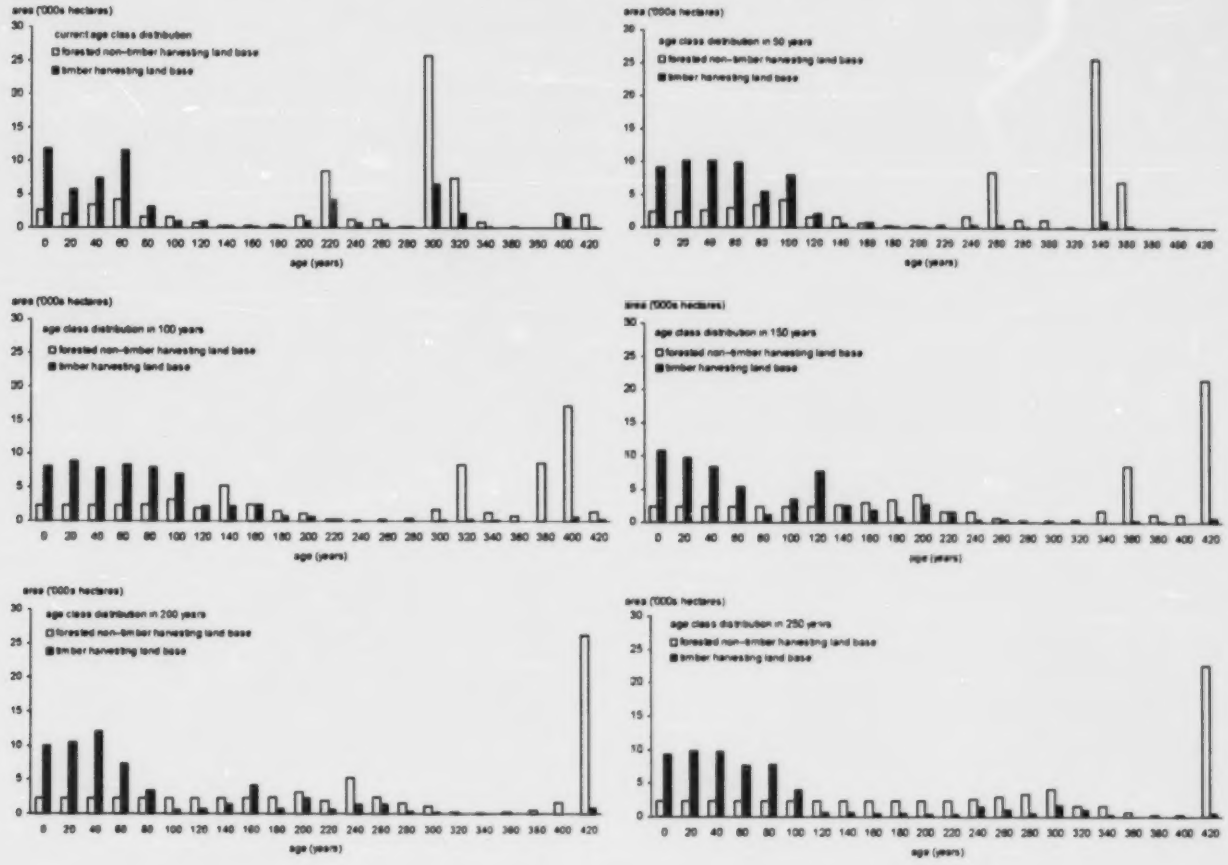
area ('000s hectares)
current age class distribution
forested non-timber harvesting land base
timber harvesting land base
age (years)
area ('000s hectares)
age class distribution in 50 years
forested non-timber harvesting land base
timber harvesting land base
age (years)
area ('000s hectares)
age class distribution in 100 years
forested non-timber harvesting land base
timber harvesting land base
age (years)
area ('000s hectares)
age class distribution in 150 years
forested non-timber harvesting land base
timber harvesting land base
area ('000s hectares)
age class distribution in 200 years
forested non-timber harvesting land base
timber harvesting land base
age (years)
area ('000s hectares)
age class distribution in 250 years
forested non-timber harvesting land base
timber harvesting land base
age (years)

Figure 14. Changes in age composition on the productive land base over time — Arrowsmith TSA base case, 2001.

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is complicated since it must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, so that decisions we make today have not only short-term but also long-term effects beyond the life spans of current decision makers. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are discussed. The results based on current forest management assumptions are referred to as the base case.

Unsalvaged losses to natural forces such as insects, fire, and wind are estimated to be 2000 cubic metres per year for the entire 250-year horizon, and have been subtracted from all harvest forecasts shown in this report.

5.1 Alternate harvest flows over time

The base case harvest forecast shown in Figure 8 was developed subject to several assumptions. For example, the initial harvest level was predetermined by the current allowable annual cut. The harvest level shown for alder-leading stands was based on the current allotment in the Arrowsmith TSA, and the length of time remaining in the existing forest licence.

Figure 15 compares two alternative forecasts with the base case. In the first alternative, the maximum even-flow harvest rate is shown. All inputs related to land base, growth and yield and management remain constant in all forecasts in Figure 15. In the second alternative, the alder harvest is maintained throughout the entire planning horizon. In the base case, the initial alder harvest of 6300 cubic metres per year is maintained for two decades, and then dropping to the long-term sustainable harvest of 3000 cubic metres per year for the remaining time. In the base case, 10% of alder stands are regenerated to alder after harvest, the remaining 90% are regenerated to medium-fir stands. In alternative 2, all alder stands are regenerated to alder, allowing the long-term harvest of alder to rise up to 6300 cubic metres per year.

Maximum even-flow (alternative 1)

- The even-flow harvest level of 286 250 cubic metres per year can be maintained for 250 years.
- This represents a 20% reduction in the short-term harvest level for the TSA and a 28% reduction from the current AAC of 400 000 cubic metres.
- Long-term harvest level is the same as the base case long-term harvest.

5 Timber Supply Sensitivity Analyses

Sustain alder harvest (alternative 2)

- The overall harvest forecast is the same as the base case.
- The alder harvest can generally be maintained at 6300 cubic metres per year for the 250-year planning horizon (except 10-25 years from now and decade 24).
- The net effect on the harvest forecast of regenerating alder stands to alder is the same as regenerating them to fir stands.

Meet current AAC (alternative 3)

- The initial harvest level is 400 000 cubic metres per year, declining at 15% per decade to the mid-term of 263 000 cubic metres per year.
- The mid-term is extended an additional 15 years before the harvest projection rises to the long-term harvest level of 286 500 cubic metres per year.

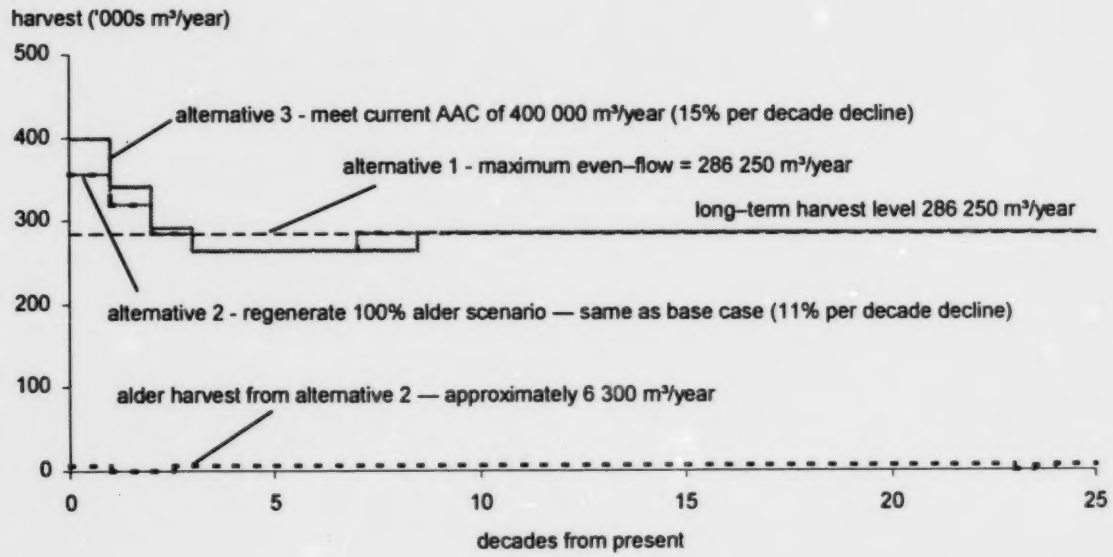

Figure 15. Alternative harvest forecasts — maximum even-flow — Arrowsmith TSA, 2001.

5.2 Uncertainty in the land base available for timber harvesting

Uncertainty in the estimated size of the timber harvesting land base is due to factors such as fluctuations in timber prices, changes in the definition of unmerchantable species, changes in harvesting and milling technology and land-use decisions. The timber harvesting land base has decreased significantly since the last timber supply analysis for the Arrowsmith TSA. While the land base area was affected by reductions for parks, protected areas*, woodlots, community forests and land exchanges, it was also affected with increases such as the inclusion of alder-leading stands.

Currently there is no indication that the timber harvesting land base has been over- or underestimated. However, sensitivity analyses were performed to provide general information that might help evaluate the implications of any new information that becomes available before the AAC determination. This sensitivity analysis evaluates the outcome of decreasing the forested land base by 10%. The second scenario evaluates a 10% increase of the forested land base. These results are discussed in subsection 5.2.1.

5.2.1 General land base uncertainty

Figure 16 shows the resulting harvest forecasts of increasing and decreasing the forested land base.

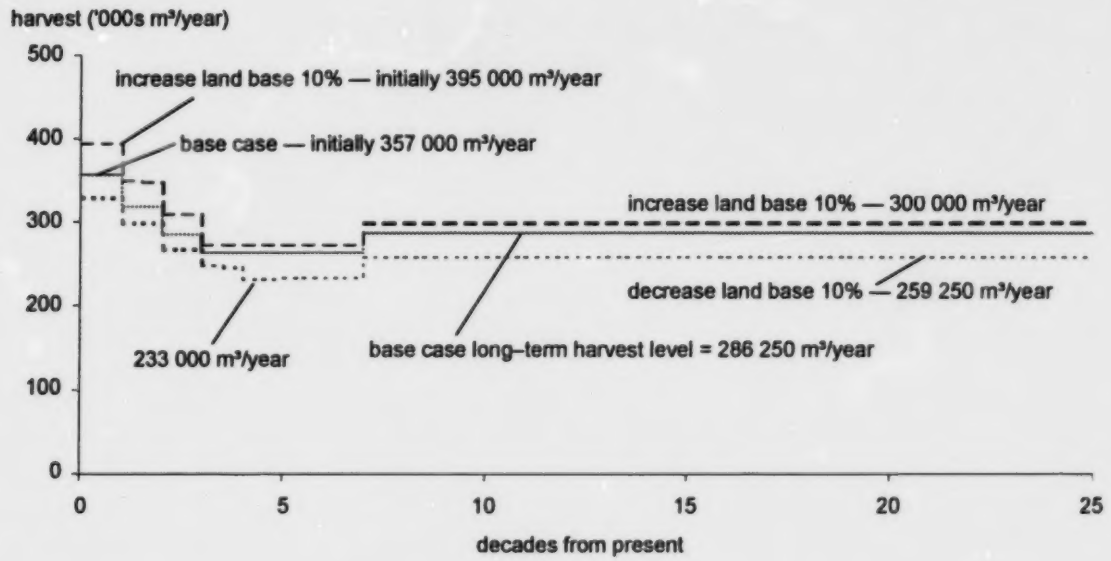

Figure 16. Land base sensitivity analysis — Arrowsmith TSA, 2001.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

Land base 10% smaller than base case

- The immediate harvest is 8% lower than the base case harvest and 18% lower than the current AAC of 400 000 cubic metres.
- The harvest then decreases by 10% per decade to a low of 233 000 cubic metres per year by the 4th decade.
- Long-term harvest level of 333 000 cubic metres per year, about 10% below the base case, reached in seven decades.

Timber harvesting land base 10% larger than base case

- Initial harvest level is 395 000 cubic metres per year, 1% below the current AAC and 11% above the base case forecast.
- The harvest declines at 11% per decade until the 4th decade.
- Long-term harvest level of 300 000 cubic metres per year is approximately 5% higher than the base case long-term level, reached in decade 7.

5.2.2 Fragmented land base

As discussed earlier, significant portions of the Arrowsmith TSA on the east coast of Vancouver Island are adjacent to large human populations. Several small parcels of crown land are surrounded by private land or are adjacent to communities, making conventional access to the land base difficult. About 9% of the timber harvesting land base for the TSA is fragmented. In the base case, these areas are modelled with a partial retention forest cover constraint, to reflect a slower rate of harvest. In this sensitivity analysis, the fragmented land base is removed from the timber harvesting land base. The timber harvesting land base in this sensitivity analysis is 54 499 hectares, or 5591 hectares smaller than the base case.

Figure 17 displays the harvest projections that result if the fragmented areas are removed from the timber harvesting land base.

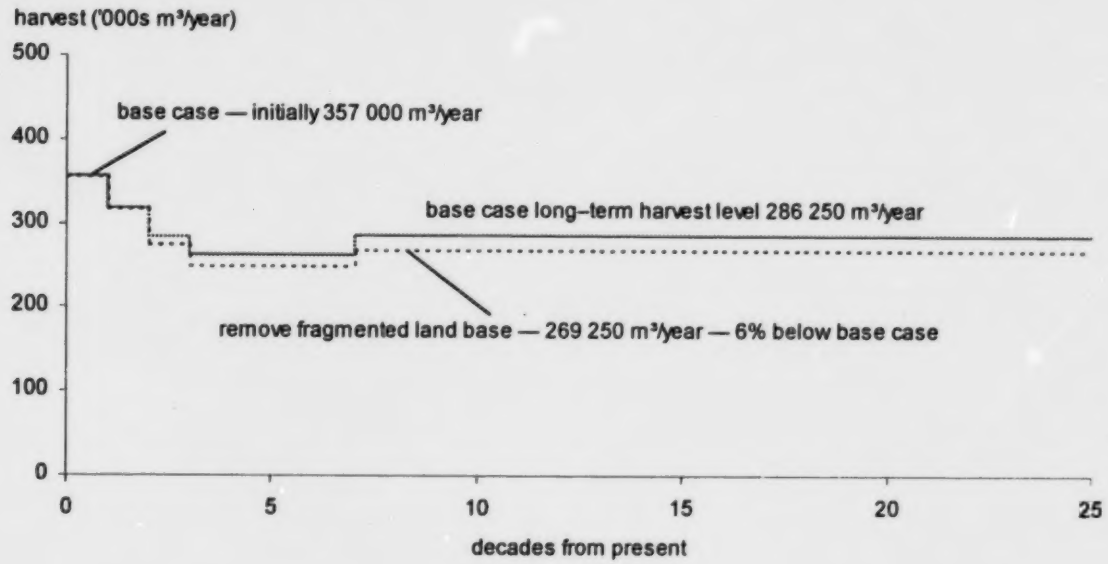

Figure 17. Remove fragmented land base sensitivity analysis — Arrowsmith TSA, 2001.

No fragmented land base

- Base case harvest level can be maintained for only 20 years, and then declines to a lower mid-term level of 249 000 cubic metres per year.
- Long-term harvest level 6% below the base case level; reached in decade 7.

5.3 Uncertainty in the estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. Timber volumes are normally accurate when averaged over large areas, but may not reflect actual volumes within individual stands. Uncertainty may also arise in the estimates of the volume lost to decay in older trees, and to waste and breakage during harvest, and of the utilization levels practiced during harvesting. A 1999 audit of the operable forested area of the Arrowsmith TSA indicated that the inventory be overestimated by 6%, however the results were not statistically significant.

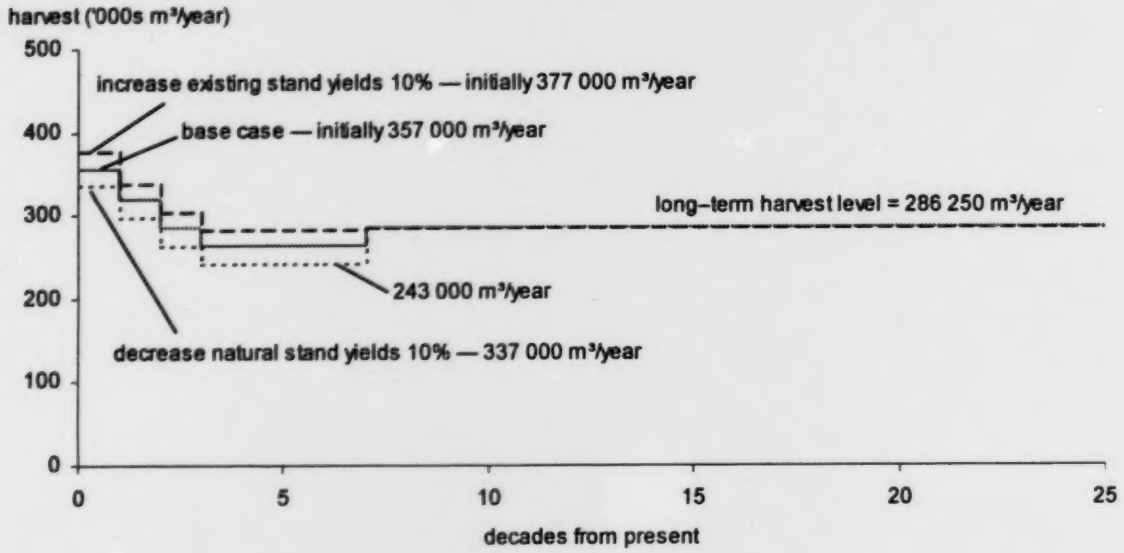

Figure 18. The effect on the harvest forecast of increasing and decreasing volume estimates for existing unmanaged stands by 10% — Arrowsmith TSA, 2001.

Existing unmanaged stand volumes decreased by 10%

- The immediate harvest level starts at 337 000 cubic metres per year, or 6% below the base case harvest forecast.
- The mid-term harvest forecast declines to a low of 243 000 cubic metres per year by the 4th decade.
- The long-term harvest level is unchanged at 286 250 cubic metres per year.

Existing unmanaged stand volumes increased by 10%

- An initial harvest level of 377 00 cubic metres per year can be maintained for one decade, 6% above the base case.
- The harvest declines 11%/decade , reaching the long-term harvest level of 286 250 cubic metres per year by the 7th decade.

5.4 Uncertainty in the estimated managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for estimated existing stand yields (inaccuracies in the forest inventory and the growth and yield models), but also because of the limited experience and data that is available for regenerated managed stands in British Columbia. In this section, the timber supply effects of uncertainty associated with predicting volumes in regenerated stands is examined.

Figure 19 shows the harvest forecasts that result when regenerated stand volumes are increased and decreased by 10%.

Regenerated stand yields decreased by 10%

- Initial harvest starts at 347 000 cubic metres per year, or 3% below the base case. The harvest level decreases by 11% per decade, to a new long-term harvest level or 264 250 cubic metres per year.
- New long-term level is 8 % below the base case long-term level.

When regenerated stand yields are increased by 10%

- Initial harvest starts at 369 000 cubic metres per year, or 3% above the base case. The harvest decreases 11% per decade in four steps.
- A new long-term harvest level of 319 250 cubic metres per year, 12% greater than the base case, is reached by the 8th decade.

Changes to regenerated stand yields do have a small effect on the short-term harvest forecast for the Arrowsmith TSA. This is primarily because increased managed stand yields help to mitigate severe shortfalls in growing stock that occur in the future, allowing the short-term harvest level to be increased now. Though some managed stands are likely to be harvested in the very near future, the harvest is not projected to be dominated by regenerated stands until about 70 years from now (refer to Figure 10)

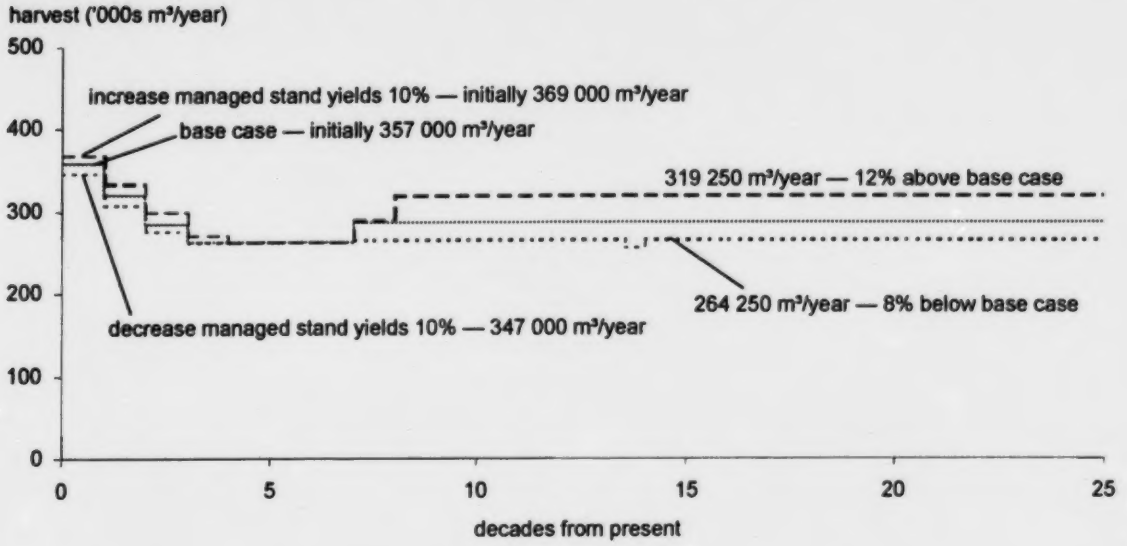

Figure 19. The effect on the harvest forecast of increasing and decreasing volume estimates for managed stands by 10%— Arrowsmith TSA, 2001.

5.5 Uncertainty about disturbance limits in visually sensitive areas

In the Arrowsmith TSA, areas determined to be visually sensitive to timber harvesting occupy approximately 33% of the timber harvesting land base. Where visual quality objectives apply, limits are placed on the percentage of the area where harvesting-related disturbance may be visible. When newly established forest reaches a specified height, the disturbance is no longer considered visible. Uncertainties are associated with both the allowable disturbance percentages and achievement of visually effective green-up. Green-up is examined later in Section 5.7.

Percentage limits on visible disturbance

The level of harvest from visually sensitive areas is a function of the scenic zone, the visual quality rating, and the current visual condition of each area. Uncertainty about forest cover and green-up objectives for visual quality may arise from inventory and classification of land into scenic zones, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality

In the base case, the applicable amount of allowable disturbance was applied to each class of VQO within a landscape unit. The allowable per cent not greened-up was based on the visual quality objective and the scenic zone it occurred within. In zone 1, the most visually sensitive, the mid-point of the allowable disturbance range was used. In zone 2, the upper limit of the allowable disturbance range was used. In zone 3, the visual quality objective (VQO) was ignored and integrated resource management (IRM) objectives were assumed. Sensitivity analyses were performed to assess the impacts of increasing forest cover constraints for visual quality.

Decreasing the allowable disturbance in visual areas

- In zone 1, the allowable disturbance was modelled to the minimum of the range for each VQO. In zone 2, the disturbance was modelled to mid-point of the range for each VQO.
- No change in the harvest forecast was found.

5.6 Uncertainty in minimum harvestable ages

Minimum harvestable ages are an estimate of the time needed for stands to reach a merchantable condition. They affect the time over which existing stands must be metered-out while regenerated stands grow to merchantability. The time at which stands will become merchantable is not known with precision because of uncertainty about the growth of regenerated stands, and an inability to foresee future conditions that will determine merchantability.

For this analysis, minimum harvestable ages for existing stands range from 40 years to 190 years and were estimated using the assumptions detailed in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Approximately 59% of the existing timber harvesting land base in the Arrowsmith TSA is currently at or above the minimum harvestable age applicable to the stand. The minimum harvestable ages for managed stands tend to be less than natural stands and range from 40 years to 160 years. Minimum harvestable ages are meant to approximate the timing of merchantability and are not legal or policy requirements.

5 Timber Supply Sensitivity Analyses

Figure 20 shows the impact of increasing and decreasing minimum harvestable ages by 10 years for each analysis unit*.

Ten year decrease in minimum harvestable ages

- No difference in short-term timber supply.
- Long–term harvest level is 281 250 cubic metres per year, or 2% below the base case harvest. (Figure 20). Stands are harvested much sooner than their maximum MAI and there is a net loss of available volume to harvest.

Ten year increase in minimum harvestable ages

- Initial harvest is 7% below the base case. This happens since increasing minimum harvestable ages also increases future shortages in merchantable growing stock. The short-term harvest must be reduced to avoid future timber supply shortages.
- Long –term harvest level is 288 250 cubic metres per year, or 0.5% above the base case harvest (Figure 20). Stands are harvested closer to the age of maximum mean annual increment and a net increase in available volume is realized in the future.

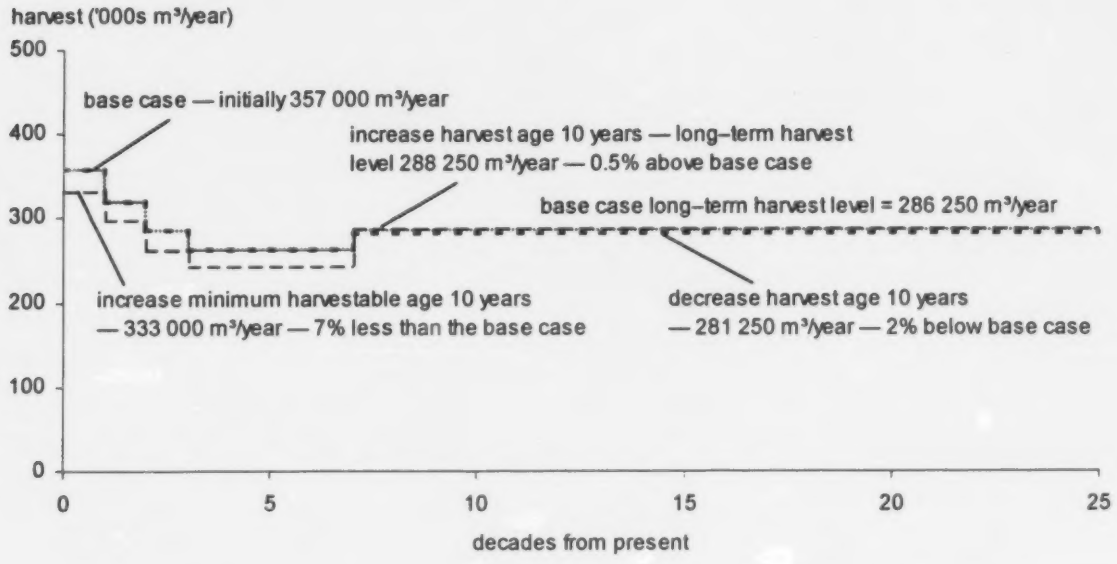
harvest ('000s m³/year)
500
400
300
200
100
0
base case — initially 357 000 m³/year
increase harvest age 10 years — long–term harvest level 288 250 m³/year — 0.5% above base case
base case long–term harvest level = 286 250 m³/year
increase minimum harvestable age 10 years — 333 000 m³/year — 7% less than the base case
decrease harvest age 10 years — 281 250 m³/year — 2% below base case
0
5
10
15
20
25
decades from present

Figure 20. The effect on the harvest forecast of increasing and decreasing minimum harvestable ages by 10 years — Arrowsmith TSA, 2001.

Analysis unit
A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.

5 Timber Supply Sensitivity Analyses

5.7 Uncertainty in green-up requirements

Within the Arrowsmith TSA base case it was assumed that no more than 25% of the timber harvesting land base within each landscape unit (LU), could be less than 3 metres in height (11 to 16 years), or less than 1.3 metres in height within the Enhanced Zones of the Vancouver Island Summary Land Use Plan. The 25% limit approximates a 4-pass harvest system. Both the percentage limitation and the age at which green-up is assumed to occur are sources of uncertainty.

Percentage allowed below green-up

To test sensitivity for this assumption, a 5-pass harvest system was modelled in the integrated resource management (IRM) areas on the timber harvesting land base. To achieve this maximum allowable area not above the 3 metre green-up was 20%.

Maximum of 20% below green-up (5-pass)

- No change from the base case harvest forecast.

Green-up for cutblock adjacency and visually effective green-up ages

Within the integrated resource management (IRM) zone and visually sensitive areas, regenerated stands in previously harvested cutblocks must reach a specified height before adjacent areas may be harvested. Within the Arrowsmith TSA, 3 metre green-up for cutblock adjacency is 11 to 16 years and 5 metre green-up for visual effectiveness is 16 to 20 years. In the Enhanced Zones of the Vancouver Island Summary Land Use Plan, a 1.3 metre green-up for cutblock adjacency is modelled in the base case (9 years). Both uncertainty around estimates of site index, and different silvicultural treatments may result in trees reaching the appropriate green-up heights sooner or later than assumed. Figure 21 shows the results of increasing and decreasing the green-up ages by five years.

Increase green-up age by 5 years.

- No change in the short- to mid-term harvest level.
- Long-term harvest level decreases to 267 200 cubic metres per year, or 7% below the base case long-term harvest level.

Decrease green-up age by 5 years.

- No change in the short- to mid-term harvest level.
- Long-term harvest level increase to 300 200 cubic metres per year, or 5% above the base case long-term harvest level.

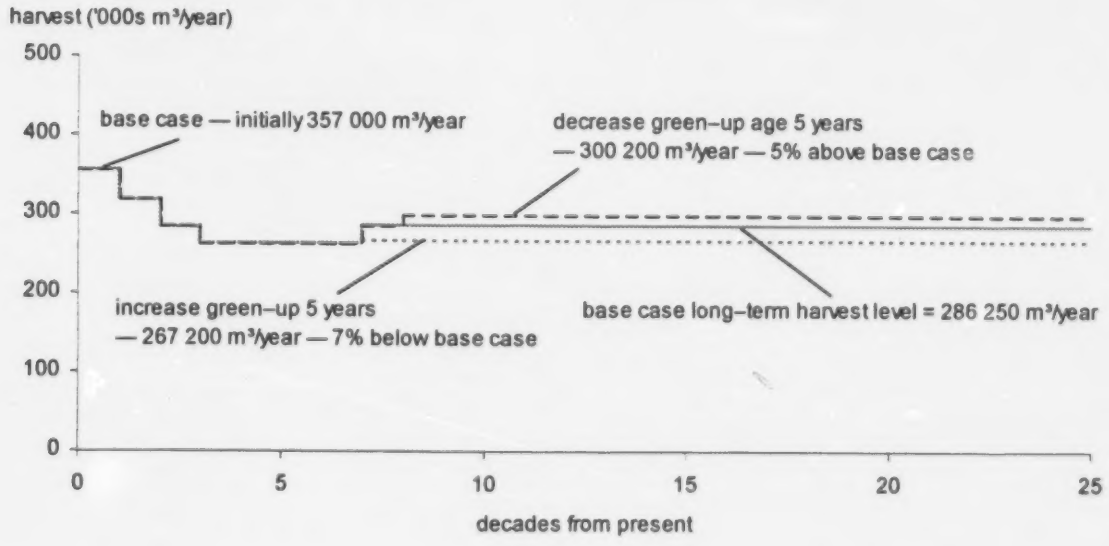

Figure 21. The effect on the harvest forecast of increasing and decreasing green-up ages by 5 years — Arrowsmith TSA, 2001.

5.8 Uncertainty in the productivity of current old-growth sites after harvest

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years a temporary increase or decrease in growth due to factors such as a post-harvest flush of nutrients or an unusual drought year can affect the overall productivity estimated for the stand. Site productivity estimates derived for older stands may be incorrect because tree heights do not represent actual productivity — for example due to top breakage — and it is very difficult to determine ages of old trees accurately. The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two Old-Growth Site Index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands and adjacent logged and regenerated stands of the same productivity. Site index was estimated for both and comparisons were made. Results are available for Douglas-fir, lodgepole pine, and interior spruce.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

The results of these studies are of interest in the Arrowsmith TSA since stands older than 140 years comprise 29% of the timber harvesting land base. To test the sensitivity of the base case harvest forecast to uncertainty about site productivity estimates, an analysis was performed that incorporated adjustments to site indexes.

OGSI adjustments

- Site indices of stands older than 140 years were adjusted for this sensitivity analysis using either the paired-plot or veteran-tree results, whichever was applicable. Managed stand volume estimates for those analysis units affected by changes in estimated future productivity were recalculated based on average adjusted site productivity. Green-up and minimum harvestable ages were also recalculated. Table 5 compares the average forest inventory-based site index for each tree species group to those defined using each of the adjustments.

5 Timber Supply Sensitivity Analyses

Table 4. Average analysis unit site index based on forest inventory, paired plot, and veteran plot — Arrowsmith TSA, 2001

Analysis unit	Timber harvesting land base area (hectares)	Inventory site index	Adjusted site index
Fir — poor east	7 061	21.7	22.0
Fir — poor west	797	19.6	19.7
Hem/balsam — poor east	524	16.6	18.0
Hem/balsam — poor west	8 295	15.5	23.2

- Average site index for the entire Arrowsmith TSA increased from 22.8 metres to 24.0 metres once OGSI adjustments were made.
- Average site index for stands greater than 140 years of age increased form 15.6 metres to 19.6 metres.

Harvest forecast with OGSI adjustments

- Harvest forecast same as base case for first seven decades (Figure 22).
- Long-term harvest level of 324 250 cubic metres per year — 13% above base case — can be maintained from decade 8 onward.

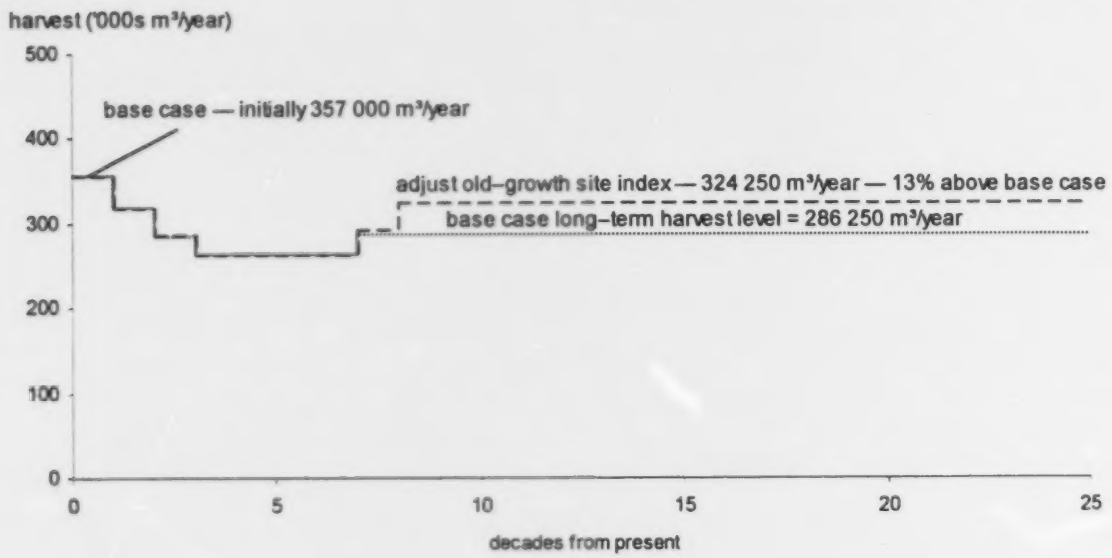

Figure 22. Harvest forecasts based on OGSI (paired plot and veteran studies) site index adjustments — Arrowsmith TSA, 2001.

Site index adjustments were not included in the base case since there is little local data, and a lack of long-term monitoring data for regenerating stands to validate the adjustments. The results of the sensitivity analysis, however, do provide insight into the trends associated with possible adjustments to site productivity estimates for the Arrowsmith TSA.

5.9 Alternative harvest queue rules

In the base case, the highest priority for harvest was given to stands that were the oldest relative to their minimum harvestable age. This 'relative oldest first' rule was applied only after other requirements and priorities (e.g., forest cover requirements) were taken into account. This rule reflects the practice of favouring older stands, but not necessarily the oldest, for harvest when all other considerations have been met.

Besides the relative oldest first rule, the Forest Service Simulator (FSSIM) model can also employ, absolute youngest first, and random scheduling rules. These other rules may better reflect practices in some instances, given unforeseeable operational constraints that may affect when stands are chosen for harvest. Figure 23 shows how timber supply is affected by changing the way harvesting priorities are set.

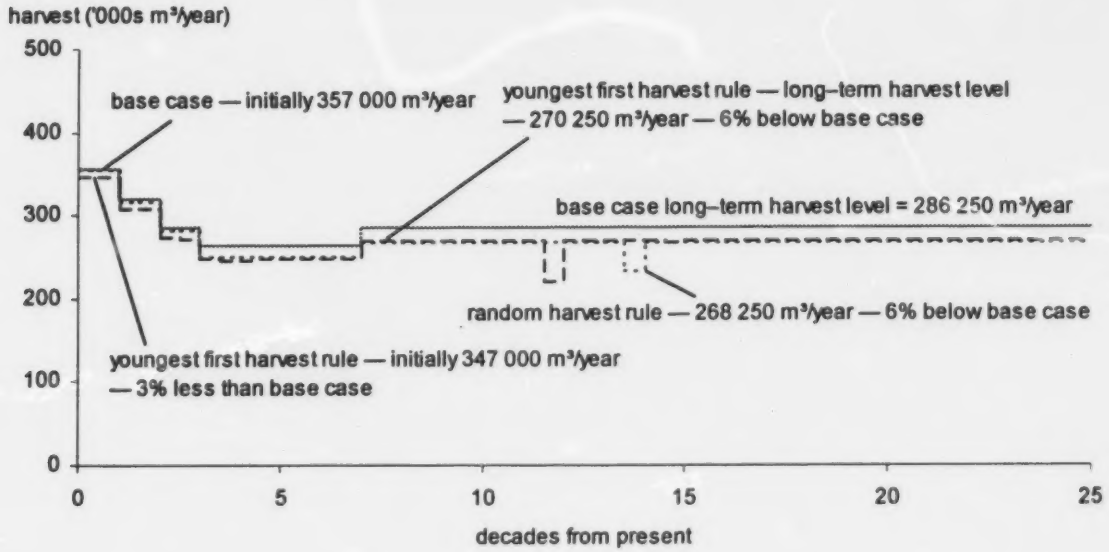

Figure 23. Alternative harvest queue (priority) rules — Arrowsmith TSA, 2001.

Absolute youngest first rule

- Sets the highest priority on the youngest stands that have reached a merchantable age.
- The initial harvest is 3% below the base case at 347 000 cubic metres per year.
- The long-term harvest level is 6% below the base case.
- This sensitivity analysis reflects how most stands could be harvested at merchantability, which is generally before maximum MAI, and still other stands may be left a very long time after they reach merchantability before they are harvested, reducing the potential MAI realized. The long-term harvest potential is reduced.

Random harvest rule

- The harvest queue is randomly shuffled in each period, so that any stand above minimum harvestable age can potentially be harvested.
- No change in the initial harvest level.
- Long-term harvest level is approximately 6% below the base case at 268 250 cubic metres per year.
- Harvesting of younger, lower volume stands early in the horizon, which would have accumulated volume if left to age further, together with retention of old stands that are not accumulating volume, combine to decrease supply over the medium- and long-term.
- The average harvest age from the random queue is approximately 98 years, compared to an average of 112 years in the base case. The youngest first average harvest age is 92 years.
- Harvesting stands further away from the age of maximum mean annual increment (MAI) causes a lower long-term harvest level.

5.10 Uncertainty in application of seral stage retention recommendations

The *Forest Practices Code Act of British Columbia* (FPC) describes the conservation of biodiversity as an essential component of sustainable forest use. The *FPC Landscape Unit Planning Guide* provides recommendations for maintaining biodiversity at both the stand- and landscape-levels. Management for landscape-level biodiversity was modelled in this analysis through the use of forest cover requirements applied to each combination of natural disturbance type, biogeoclimatic subzone, and variant within each landscape unit. In the base case, old-growth targets, as found in the *Landscape Unit Planning Guide*, were applied at the biogeoclimatic variant level within each draft landscape unit. These targets were calculated based on the draft biodiversity emphasis option (BEO) assigned to each landscape unit. In areas subject to the lower BEO, an initial draw down of the old-seral requirements to one-third of the target was allowed in the base case.

While the approach used in the base case represents current policy for managing and modelling landscape-level biodiversity, there is uncertainty about how the recommendations in the *Landscape Unit Planning Guide* will be applied once landscape units and BEOs are declared.

Three sensitivity analyses were performed to evaluate the potential timber supply impacts associated with uncertainty about landscape-level biodiversity management. Figure 24 shows the results.

Old-seral targets must be met immediately (priority biodiversity) in all landscape unit — biogeoclimatic variant combinations – no drawdown of the old seral target

- The required amount of old-seral stands in low BEO landscape units is modelled to the full-seral target as required in the *Landscape Unit Planning Guidebook*.
- Only impact is a minimal dip in the 14th decade, causing a likely very small reduction in the long-term harvest level.

Meet old, mature and early targets immediately in all biogeoclimatic zone variant combinations, allow for drawdown of old seral to one-third of target in low BEO landscape units

- A slight dip during the 13th decade of the harvest forecast.
- Meet old, mature, and early seral targets immediately in all biogeoclimatic zone variant combinations
- A larger dip is caused during the 13th decade of the harvest forecast. A drop in the long-term harvest level is likely necessary to avert this dip.

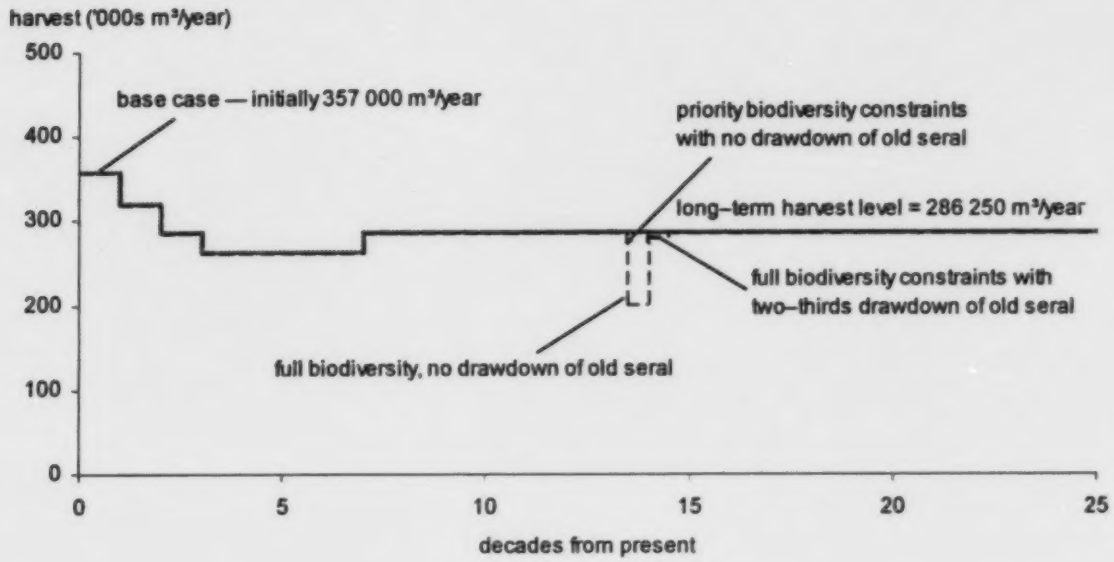

Figure 24. The effect on the harvest forecast of altering biodiversity assumptions — Arrowsmith TSA, 2001.

5.11 Uncertainty in retention harvesting assumptions

In recent years, several British Columbia forest companies have made commitments to move away from clearcut silvicultural systems to systems that reflect more partial harvesting of stands. One term that has been coined to describe these systems is retention harvesting. Retention is characterized by smaller harvest openings where some trees are retained in groups within the opening or dispersed as individuals throughout the opening, to help meet objectives for biodiversity, habitat and scenic quality. Trees that are retained after harvest are typically retained for long-term, generally one rotation. The retention of trees in the stand after harvest has obvious impacts on volume extracted, over and above clear cutting, as well as potentially significant growth and yield impacts of future stands growing under retention stands.

A number of large licensees, as well as the Small Business Forest Enterprise Program (SBFEP), have now started to practice retention harvesting in the Arrowsmith TSA. In order to estimate the impact that retention is having on harvest volumes, a review of silvicultural prescriptions from the licensees and the Small Business Forest Enterprise Program was conducted. It was found that on average, across the TSA, retention was leaving 8.5% additional area in reserves within cutblocks, over and above those already left for *Forest Practices Code* requirements like riparian and wildlife tree patches (WTP). To model this in the base case, it was assumed that one-half of this 8.5% was being left on the timber harvesting land base. Volume tables for both managed and unmanaged stands were reduced by 4.25%.

Residual trees retained within a cutblock have shading effects on the understorey crop, potentially reducing their future growth. The shading effect can vary, depending on how residual trees are left. Trees dispersed throughout a cutblock can cast more shade, greatly reducing growth. Trees aggregated in groups can reduce the shading effect on regeneration growth. Retention harvesting is quite recent on the coast and there is still little scientific work done to investigate the magnitude of these growth impacts. One source of information *is TFL 39, MP #8 Timber Supply Analysis Information Package, October 1999.* Weyerhaeuser suggests that the growth and yield impacts of retention can range from 3% to 30%, depending on the amount retention left and dispersion of residual trees. For the purposes of sensitivity analysis, an additional reduction for growth of 5% has been assumed for the Arrowsmith TSA.

To examine the effects due to growth reduction and the amount of variable retention being left on the timber harvesting land base, the volume reduction was increased from 4.25% in the base case to 8.5% and with an additional growth reduction of 5% for future regenerated stands. A second sensitive analysis was conducted where the volumes were reduced by only 2.1% with no further reduction to account for shading. Figure 25 shows the results of these analyses.

<u>Increase retention reduction to 8.5% with additional 5% growth impact</u>

- The initial harvest level is 347 000 cubic metres per year, 3% below the base case.
- Reductions to the harvest forecast are relatively constant throughout the long term with the additional 5% growth impact. The long-term harvest forecast is 9% below the base case.
- Since the reduction for variable retention is made to all volume tables, the short, mid- and long-term harvests are all impacted by an amount proportional to the additional reduction of 4.25%.

Decrease retention reduction to 2.1%

- An initial increase of 4% to 371 000 cubic metres per year is possible.
- In the long term, the harvest level is 1% higher than the base case, or 291 250 cubic metres per year.
- Again since the reduction for variable retention is made to all volume tables, the short-, mid- and long-term harvests are generally increased proportionately. A slightly larger increase of 4% is possible in the short-term harvest.

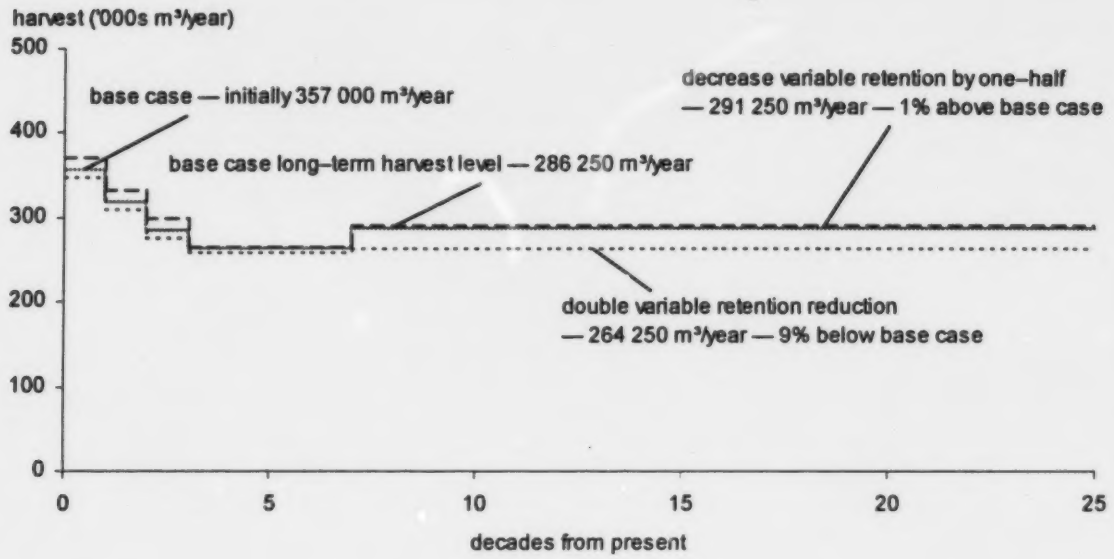

Figure 25. The effect on the harvest forecast of altering variable retention assumptions — Arrowsmith TSA, 2001.

5.12 Uncertainty in commercial thinning

Commercial thinning is currently practiced in the Arrowsmith TSA in good and medium fir sites on the east coast of Vancouver Island. In the base case, the first 20 years of the harvest forecast contain a maximum of 23 700 cubic metres per year of commercial thinning (approximately 165 hectares per year). This 23 700 cubic metres per year represents current performance by licensees at the time the data package was developed. Since then, market prices for small fir logs has dropped and the amount of commercial thinning has dropped significantly. This sensitivity analysis investigates changes in assumptions around the quantity of commercial thinning.

Maximum of 50 hectares per year of commercial thinning for next two decades and a maximum of 100 hectares per year for remaining 23 decades.

- No change from the base case was found.

Commercial thinning was modelled in the base case as a volume neutral system. Commercial thinning neither increased nor decreased the volume of thinned stands (when compared to clearcuts). Since commercial thinning is modelled as volume neutral, the quantity of commercial thinning does not effect the short- or long-term harvest forecast.

5.13 Summary of sensitivity analyses

Table 6 summarizes all sensitivity analyses. Sensitivity analyses showing an increase relative to the base case harvest forecast are presented first, followed by those showing a decrease. Sensitivity analyses showing no impact relative to the base case are presented last.

Table 5. Summary of sensitivity analysis — Arrowsmith TSA, 2001

Report section	Description	Impact of sensitivity analysis relative to the base case		
		Short term	Medium term	Long term
5.2.1	Increase timber harvesting land base	+	+	+
5.3	Increase existing stand volumes	+	+	
5.4	Increase managed stand yields	+		+
5.11	Decrease reduction for variable retention	+	+	+
5.7	Reduce green-up delay in visual areas			+
5.6	Increase minimum harvestable age	–	–	+
5.8	Old-growth site index adjustments			+
5.1	Maximum non-declining even-flow	–	+	
5.2.1	Reduce timber harvesting land base	–	–	–
5.9	Youngest first harvest rule	–	–	–
5.9	Random harvest rule		–	–
5.3	Reduce existing stand volumes	–	–	
5.4	Reduce managed stand volumes	–		–
5.7	Increase green-up delay in visual areas	–	–	–
5.11	Increase reduction for variable retention	–	–	–
5.6	Decrease minimum harvestable age			–
5.2.2	Exclude fragmented land base		–	–
5.10	Full biodiversity — no drawdown of old seral		–	–
5.10	Full biodiversity with two-thirds drawdown of old seral			–
5.10	Priority biodiversity			
5.10	No drawdown of old seral			–
5.12	Limit amount of commercial thinning			
5.7	Change to a 5-pass harvest system			

6 Summary and Conclusions of the Timber Supply Analysis

The results of this timber supply analysis suggest that, given changes in the land base since the last determination and other data management and assumptions that reflect current information and practices, the current allowable harvest level in the Arrowsmith TSA of 400 000 cubic metres per year cannot be maintained. Based on the current information a harvest level of 357 000 cubic metres per year could be achieved, an 11% decrease from the current AAC. This harvest forecast has three distinct parts: 1) 6300 cubic metres per year for the ten years remaining in the term of the alder leading forest licence; 2) 11 000 cubic metres per year in Clayoquot Sound, 20% below the current partition* of 13 700 cubic metres; and 3) 339 700 cubic metres per year from conventional areas outside of Clayoquot Sound, 11% below the current partition of 380 000 cubic metres. After one decade, the projected harvest level declines by 11% per decade, to a medium-term harvest level of 263 000 cubic metres per year and returning to a steady level of 286 250 cubic metres per year in 70 years.

A series of sensitivity analysis showed that data and management uncertainties affect timber supply projections to varying degrees, some with positive impacts and others with negative impacts.

The uncertainties with the largest potential to affect the base case projection of short-term harvest levels (next 20 years) are estimates of timber volumes in existing stands, the size of the timber harvesting land base, and the amount of area allowed below green-up height on the timber harvesting land base at any time. An inventory audit completed in 1999 showed that the inventory estimate of volume in mature stands (over 60 years old) was approximately 4% overall (6% in the operable land base) above the estimate derived from ground samples. This potential overestimation in inventory volumes was not statistically significant.

Increases in managed stand yields can also potentially increase short-term harvests. Increased volumes available in the future can make more timber available in the short term for harvest. Similarly, decreasing managed stand yields decreases the short-term timber supply.

Medium-term (21 to 100 years from now) timber supply is affected by many of the factors tested through sensitivity analysis. Because the long-term harvest level is about 20% lower than the starting harvest level, changes in factors that alter either the total amount or ability to access existing volume during the first 100 years will affect medium-term timber supply. The medium term is affected by changes in: the size of the timber harvesting land base; volumes from existing and managed stands; minimum harvestable ages; and harvest rule assumptions.

Sensitivity analysis in which the fragmented parcels (6% of the timber harvesting land base) were removed from the timber harvesting land base showed reductions to the harvest level in the medium- and long-term of approximately 6%.

Changes in the estimates of volumes in existing stands and in the amount of the land base that is available for harvesting have direct and approximately proportional effects on medium-term supply. In addition, changes in the size of the timber harvesting land base cause proportional increases or decreases in the long term. Increases in minimum harvestable ages exacerbate long-term supply problems and decrease the short- and mid-term harvest forecasts.

Another factor with potential impacts on medium- and long-term timber availability is the rule used to set harvest priority. The analysis shows significant impacts when the highest priority was placed on stands that had just reached minimum harvestable age (youngest-first rule), or when the harvest of stands is scheduled randomly, rather than the relative oldest first rule used in the base case. It is unlikely that younger stands would always be given higher harvest priority than older stands, or that the harvest schedule will be completely random. Nevertheless, the analysis shows the potential impacts on timber supply from different harvest priorities.

Partition
A portion of the AAC that is attributable to certain types of timber and/or terrain.

6 Summary and Conclusions of the Timber Supply Analysis

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand volumes. Uncertainties about the implementation of landscape-level biodiversity constraints can have small impacts on the long-term harvest. Increases in seral stage biodiversity requirements will reduce the long-term harvest level.

If site productivity is underestimated for existing old-growth stands as suggested by recent research, yields in regenerated stands could be significantly higher than in the base case harvest forecast which would boost the long-term harvest level.

In conclusion, this analysis indicates that based on current land base inventory, growth and yield, and forest management information, timber harvests in the Arrowsmith TSA could be supported at 357 000 cubic metres per year for the next decade, 11% below the current AAC. This base case harvest forecast is comprised of an 11% reduction of the conventional harvest outside Clayoquot to 339 700 cubic metres; a 20% reduction of the Clayoquot Sound harvest to 11 000 cubic metres and maintaining the alder harvest at 6300 cubic metres. The analysis indicates that several factors related to the current forest inventory, land base, and management regime could affect timber supply. However, with the exception of potential underestimating site indices for old-growth stands, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. The socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Arrowsmith TSA to the level of activity that the TSA could support as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines harvest levels as projected in the base case harvest forecast and is not intended to examine alternative management scenarios.

The socio-economic analysis consists of the following:

- a profile of the current socio-economic setting;
- a description of the Arrowsmith TSA forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

7.1 Current socio-economic setting

7.1.1 Current population and demographic trends

The Arrowsmith TSA is part of the South Island Forest District, which also includes Tree Farm Licences (TFL) 44, 46, 54 and 57, plus a portion of TFL 25. In 2000, the population of the South Island Forest District was approximately 557,900 people.[1] Outside of the Vancouver Lower Mainland, Southern Vancouver Island has the largest concentration of population in the province. The largest population centre in the South Island Forest District is the Capital Regional District (CRD), including the City of Victoria, with an estimated 2000 population of 334,940 people. Other communities located in the forest district include Duncan, Ladysmith and numerous other communities located along the east coast of Vancouver Island and the Gulf Islands up to Nanaimo and beyond to Parksville and Qualicum Beach, to the northwest of the CRD past Port Renfrew to Ucluelet and Tofino, and back towards the eastcoast through Port Alberni.

The population of the forest district is expected to increase by approximately 5.3% between 2000 and 2005. Projected population growth rates for areas within the forest district range from an increase of 10% and 7.9% in the Nanaimo and Cowichan Valley Regional Districts, respectively, to a decline of 2.2% in the Alberni-Clayoquot Regional District. Table 6 shows the population levels for the South Island Forest District, regional districts and selected communities.

(1) British Columbia Stats, Population Section, British Columbia Ministry of Finance and Corporate Relations. Estimate for 2000 based on population growth rates in the Alberni-Clayoquot, Nanaimo, Cowichan Valley, and Capital Regional Districts.

7 Socio-Economic Analysis

Table 6. South Island Forest District population statistics, 1991-2005

	1991	1996	2000	2005	% change 1991-2000
Port Alberni	18,886	19,201	19,329	N/A	1.9
Duncan	4,411	4,761	4,766	N/A	8.0
Ladysmith	4,997	6,704	6,963	N/A	39.3
North Cowichan	21,913	26,275	27,612	N/A	26.0
Lake Cowichan	2,295	2,966	3,086	N/A	34.5
Ucluelet	1,642	1,731	1,824	N/A	11.1
Nanaimo	61,708	72,950	76,645	N/A	24.2
Parksville	7,476	9,816	10,613	N/A	42.0
Alberni-Clayoquot Regional District	32,048	32,906	33,408	32,671	4.2
Nanaimo Regional District	104,296	126,483	134,929	148,528	29.4
Cowichan Valley Regional District	62,199	73,676	76,362	82,850	22.8
Capital Regional District	307,643	331,761	334,940	349,019	8.9
South Island Forest District	495,740	545,490	557,900	587,370	12.5
British Columbia	3,282,910	3,882,043	4,063,760	4,372,208	23.8

Source: Census of Canada 1991, 1996.
2000 estimates and 2005 projections from British Columbia Stats Population Section.
www.bcstats.gov.bc.ca/data/pop/popstart.htm
N/A: not available.

7 Socio-Economic Analysis

Recent population growth rates have not been consistent throughout the forest district. Table 6 illustrates the differences between the northern and southern portion of the South Island Forest District. In all areas, the majority of the population growth occurred in the first half of the decade. The northern portion of the forest district has experienced substantial population growth over the past decade. From 1991 to 2000, the Nanaimo Regional District's population grew by 29%, ahead of growth in the Greater Vancouver Regional District (27%), but behind growth in the Squamish-Lillooet Regional District, which includes Whistler (45%). Growth in the Nanaimo Regional District centred on the municipalities of Parksville, which grew by 42% from 1991 to 2000, and Qualicum Beach, which grew by 38%. The Parksville to Coutenay/Comox[2] corridor experienced the largest population growth rates on Vancouver Island. Nanaimo also had a relatively high population increase averaging 24% over the decade. Other communities that had above average growth rates include Tofino and Ladysmith, which had respective growth rates of 36% and 39% from 1991 to 2000. Conversely, The City of Victoria and Port Alberni experienced only 2% population growth rates during the decade.

7.1.2 Economic profile

From 1991 to 1996, the total experienced labour force in the South Island Forest District increased by 13% to 277,105 from 245,355.[3] In comparison, the provincial experienced labour force increased by 14% over the same period. The unemployment rate in the South Island Forest District was 9.3% in 1996 compared to 9.1% in 1991. The labour force will increase as the population increases; however, similar to the concentration of population growth, it is likely that much of the increase will occur in the communities showing the most population growth. The exception to this trend would be in communities where retirees form the majority of the population increases.

(2) The population of the communities of Courtenay and Comox, which are outside of the South Island Forest District, grew by a combined 57%.

(3) Census of Canada, 1991, 1996.

7 Socio-Economic Analysis

Figure 26 shows total employment dependencies by sector for the South Island Forest District. The forest district has a number of distinct economic regions, which the following figure does not reflect. Variations between the southern, middle and northern portions of the district are highlighted in discussion below.

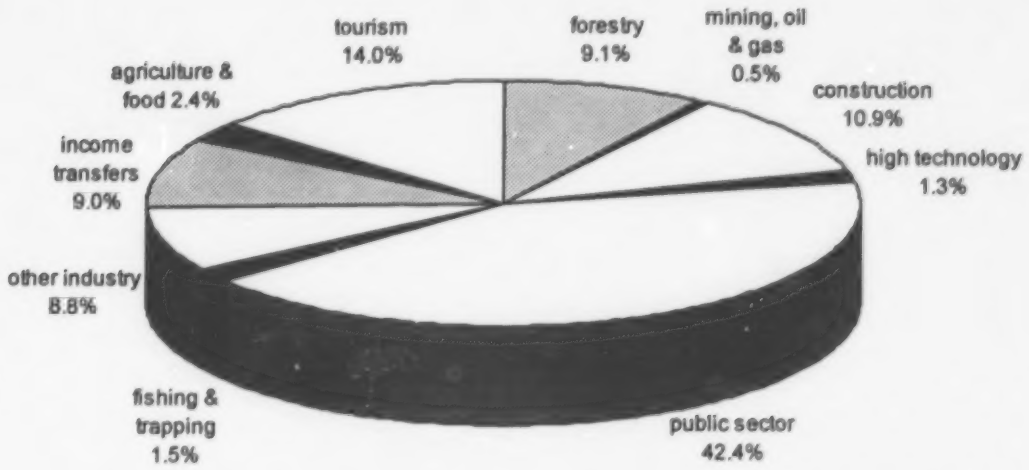

Figure 26. South Island Forest District experienced labour force by sector, 1996.

Source: British Columbia Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.

7 Socio-Economic Analysis

The public sector is the leading employer in the South Island Forest District and in 1996 supported 42% of the total labour force and was the source of 34% of total income. The public sector includes municipal, provincial and federal government employment, including education and health services and its dominance is obviously a reflection of the City of Victoria being the provincial capital. In comparison, the public sector accounted for on average 23% of the employment in forest districts across the province. The district wide average percentage hides sub-regional differences. While the Capital Regional District relies on the public sector for a substantial portion of its income (41%), the public sector is far less important in other areas of the forest district such as Lake Cowichan, Parksville-Qualicum, and the Gulf Islands where the public sector accounts for less than 20% of income.

The tourism sector in the South Island Forest District was the second largest employer supporting 14% of the labour force. The tourism sector in Figure 26 includes both business and tourism travel. While this sector is a leading employer it is the source of only 6.3% of the income flowing into the region. The difference between the percentage employed and income reflects the level of wages earned by the average travel sector worker and the magnitude of business-related supply and service spending. Regional differences are also present in the tourism sector. Tourism accounted for a low of 3% of income in Duncan to 8% of income in the Parksville-Qualicum area.

In 1996, the forestry sector supported just over 9% of the workforce in the South Island Forest District and was the source of about 8% of the income flowing into the region. The forestry sector includes harvesting, silviculture, and forest products manufacturing. The role of forestry varies substantially among the sub-regions of the forest district. In Port Alberni and Lake Cowichan the forestry sector accounted for 36% and 33% of income, respectively. In Ladysmith and Duncan the forestry sector accounted for 24% and 20% of income, respectively. In contrast to these more forestry dependent areas, in Victoria and the Gulf Islands forestry accounted for about 1% of income, and in the Parksville-Qualicum area forestry accounted for 8% of the income flowing into the region.

From 1996 to 2000, the forest products manufacturing sector declined by approximately 15% in the South Island Forest District. Specific regional data are not available for changes in logging and forestry services employment since 1996, but declines in this sub-sector have occurred, given a 15% reduction in the timber supply of management units within the South Island Forest District. Due to the changes in manufacturing and probable changes in logging and related employment, the region's income dependency on the forestry sector has likely declined, but by how much will not be certain until data from the 2001 Census of Canada is available.

In some parts of the South Island Forest District, investment income, pensions and other transfer related income (employment insurance and other social assistance payments for example) have become the leading sources of income. This is a direct result of the mild climate and high level of services that has attracted numerous retirees to the area. The most notable areas are the Gulf Islands and Parksville-Qualicum where in 1996 transfer income accounted for 52% and 46% of the income, respectively. These income dependency levels are some of the highest in the province. Most other sub-regions of the forest district have income dependencies of at least 30% while the lowest is in the Port Alberni area where transfer incomes accounted 25% of income. While the dependency on transfer incomes is high, the employment supported by this income is relatively low, as indicated in Figure 26 in which transfer income accounts for only 9% of total employment. The reason for this apparent anomaly is that those receiving transfer payments are not counted as employed; only the induced employment at supply and service businesses, such as grocery stores for example, is included in labour force figures. As the population ages, pension income will become an even greater source of income in those communities providing convenient activities, other amenities and health services.

7 Socio-Economic Analysis

The remaining employment in the South Island Forest District is supported by employment in construction activity, agriculture, mining, high technology, and other transportation, manufacturing and construction activities not associated with any of the other major sectors.

The indirect and induced employment included in Figure 26 reflects the income spent by companies and employees and the number of jobs that depend on those expenditures. Employment multipliers illustrate this spending effect: a larger multiplier indicates that each job of a particular sector will support more business activity at supply and service companies, due to higher company revenues, supply requirements and wages. For example, multiplier estimates indicate that every 100 full-time direct forestry jobs in the South Island Forest District support an additional 57 to 104 indirect and induced full-time jobs, depending on the forestry activity (harvesting or processing).[4] In comparison, every 100 full-time direct jobs in the tourism and business travel sector support an estimated 19 indirect and induced jobs*, and every 100 jobs in the public sector support an additional 38 indirect and induced jobs. The differences are due to larger spending patterns by forestry sector businesses and their employees, which tend to have higher revenues and incomes. The multipliers indicate how a change to a particular sector could affect the broader economy.

Table 7 compares employment multipliers among sectors of the South Island Forest District economy.

Table 7. Employment multipliers, by sector, for the South Island Forest District, 1996

Basic sector	Employment multiplier
Forestry: logging and manufacturing	1.57 – 2.04
Agriculture and food	1.32
Travel and tourism	1.19
Public sector	1.38
Mining	1.73
High tech	1.41

Source: British Columbia Ministry of Finance and Corporate Relations. 1999. The 1996 forest district tables.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

(4) British Columbia Ministry of Finance. 1999. The forest district tables. Victoria, B.C.

7 Socio-Economic Analysis

7.2 Arrowsmith TSA forest industry

7.2.1. Current allowable annual cut

The current (effective July 1996) allowable annual cut (AAC) for the Arrowsmith TSA is 400 000 cubic metres. Table 8 provides a breakdown of the AAC by tenure type. Prior to July 1996, the AAC was 484 500 million cubic metres.

Table 8. Arrowsmith TSA allowable annual Cut, by licence type

	AAC (cubic metres)	Per cent (%) of total AAC
Forest licences — replaceable	151 419	37.9
Forest licences, non-replaceable	74 935	18.7
Small Business Forest Enterprise Program (SBFEP)	148 797	37.2
Timber sale licences > = 10 000 m^3	11 349	2.8
Woodlot licence	12 500	3.1
Forest Service reserve	1 000	0.3
Total	400 000	100

Source: Ministry of Forests.

7.2.2 Arrowsmith TSA harvest history

Table 9 summarizes the volume of timber harvested in the Arrowsmith TSA from 1993 to 2000. The actual volume of timber harvested is an important indicator of forestry activity in the TSA. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity. Differences in annual harvest levels are the result of provisions for cut-control[5] variations that allow licensees to vary their harvests based on operating and market conditions. If actual annual harvest levels are consistently less than the AAC, then forestry activity is below its full potential.[6]

(5) Cut control allows licensees to vary the volume between annual harvest and AAC by +/– 50 % per year, and by +/– 10 % over a 5-year cut-control period.

(6) Full potential referred to here is based on the allocated volumes of the AAC, and is not necessarily the same as full economic potential which is based on the international market for wood products.

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In 2000, 324 576 cubic metres were harvested from the Arrowsmith TSA, (see Table 9). During the 1993 to 1997 cut-control period, the full allocation of timber was harvested from the TSA. The latest cut-control period runs from 1998 to 2002 and a lower level of harvesting activity has been experienced to date.

Table 9. Arrowsmith TSA volumes billed, by licence type, 1993 to 2000

	Cubic metres (m^3)							
Tenure	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Forest licence (FL)	174 207	177 473	176 027	198 076	180 546	119 477	185 994	219 020
Small Business Forest Enterprise Program (SBFEP)	296 918	18 824	291 919	284 400	205 480	121 172	109 140	101 660
Timber sale licence (TSL)	24 453	21 785	514	15 683	2 178	902	8 354	3 857
Other[a]	4 297	5 194	6 038	2 453	1 300	341	139	40
Total	499 876	392 676	474 498	500 612	389 504	241 892	303 626	324 576
AAC[b]	484 500	484 500	484 500	484 500	400 000	400 000	400 000	400 000
Average harvest 1993–1997:	451 433							
Average harvest 1998–2000:	290 031							

(a) "Other" consists of cutting permits such as rights-of-way, road permits, and other small temporary permits.

(b) The AAC was lowered to 484 500 in April 1993 and then to 400 000 cubic metres on December 30, 1996.

Source: Ministry of Forests.

7.2.3 Arrowsmith TSA major licensees and processing facilities

International Forest Products Ltd.

International Forest Products Ltd. (Interfor) has a replaceable forest licence in the Arrowsmith TSA to harvest 110 190 cubic metres of timber. In 2000, Interfor harvested 88 627 cubic metres under its Arrowsmith TSA licence. Table 10 outlines Interfor's recent harvest activity and 1998-2000 average employment levels associated with its Arrowsmith TSA operations.

Table 10. Interfor volumes billed and provincial employment statistics

Allowable annual cut (AAC)	110 190 cubic metres
2000 harvest[a]	88 627 cubic metres
1998-2000 average volumes billed	85 925 cubic metres
Employment[b] (1998-2000 person-years)	
Harvesting and silviculture	31
Processing	43
Total	74

(a) Harvest levels include forest licence and cutting permit volumes.

(b) The employment figures relate to the 1998-2000 average volume of 85 925 cubic metres harvested from the Arrowsmith TSA only and processed in British Columbia.

Interfor currently operates six lumber mills in the province, none of which are located in the Arrowsmith TSA. Five of Interfor's mills are located in the Squamish-Vancouver area and one is located at Adams Lake, east of Kamloops. From 1998 to 2000, the sawmills processed an average of about 2.6 million cubic metres per year. In April, 2001, Interfor announced that by the end of October it will close its Fraser Mills facility in Coquitlam, reducing the number of lumber mills Interfor operates in the Lower Mainland to three. The Arrowsmith TSA represents approximately 4% of Interfor's total mill consumption.

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Coulson Forest Products Limited

Coulson Forest Products Limited (Coulson) has a replaceable forest licence in the Arrowsmith TSA to harvest 41 229 cubic metres of timber. In 2000, Coulson harvested 62 128 cubic metres under its Arrowsmith TSA licence. Table 11 outlines Coulson's recent harvest activity and 1998-2000 average employment levels associated with its Arrowsmith TSA operations.

Table 11. Coulson volumes billed and provincial employment statistics

Allowable annual cut (AAC)	41 229 cubic metres
2000 harvest[a]	62 128 cubic metres
1998-2000 average volumes billed	27 432 cubic metres
Employment[b] (1998-2000 person-years)	
Harvesting and silviculture	17
Processing	19
Total	36

(a) Harvest levels include forest licence and cutting permit volumes.

(b) The employment figures relate to the 1998-2000 average volume of 37 432 cubic metres harvested from the Arrowsmith TSA only and processed in British Columbia.

Coulson operates a sawmill located in Port Alberni. The mill has the capacity to produce approximately 43.2 million board feet of lumber per year. The Arrowsmith TSA supplies approximately 15% of the mill's timber requirements.

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Cowichan Lake Community Forest

Cowichan Lake Community Forest (Cowichan Lake) has a non-replaceable forest licence in the Arrowsmith TSA to harvest 14 885 cubic metres of timber per year. In 2000, Cowichan Lake harvested 31 794 cubic metres under its Arrowsmith TSA licence. Table 12 outlines Cowichan Lake's recent harvest activity and 1998-2000 average employment levels associated with its Arrowsmith TSA operations.

Table 12. Cowichan Lake volumes billed and provincial employment statistics

Allowable annual cut (AAC)	14 885 cubic metres
2000 harvest[a]	31 794 cubic metres
1998-2000 average volumes billed	19 770 cubic metres
Employment[b] (1998-2000 person-years)	
Harvesting and silviculture	8
Processing	10
Total	18

(a) Harvest levels include forest licence and cutting permit volumes.

(b) The employment figures relate to the 1998-2000 average volume of 19 770 cubic metres harvested from the Arrowsmith TSA only and processed in British Columbia.

The timber harvested under the Cowichan Lake licence was milled at or traded for wood to be milled at the Youbou lumber mill operated by TimberWest Forest Ltd. The recent closure of the lumber mill will redirect this timber supply; however, how and where the timber will be used is unknown at this time. Cowichan Lake is currently looking into options, including the operation of some form of value-added or specialty mill.

Other licensees

Northwest Hardwoods Ltd. (Northwest), formerly Coast Mountain Hardwoods, is owned by Weyerhaeuser and has a non-replaceable forest licence in the Arrowsmith TSA to harvest 6300 cubic metres from deciduous-leading stands. In 2000, Northwest harvested 2654 cubic metres. Northwest operates a sawmill in the Vancouver Lower Mainland. The mill processes hardwood lumber and has the capacity to produce approximately 40-50 million board feet per year. The Arrowsmith TSA accounts for a minor portion of Northwest's timber supply requirements.

Other non-replaceable forest licences in the TSA include Equis Forest Products Ltd. and Echa-Peh Forest resources Ltd, each with a licence to harvest 20 000 cubic metres per year; both licences were issued in 1998 for 15 years and have experienced start-up delays. At the time of writing Equis had no cutting permits issued. Echa-Peh had cutting permits approved and began harvesting timber in 2001. The Arrowsmith TSA also has a major timber sale licence held by Steeves Forest Consulting Ltd. to harvest 10 782 cubic metres per year. In 2000, Steeves harvested 3800 cubic metres.

The remainder of the Arrowsmith TSA timber supply is harvested under the Small Business Forest Enterprise Program (SBFEP). The total AAC apportioned to the SBFEP is 148 797 cubic metres. In 2000, the total volume harvested under the SBFEP was 101 660 cubic metres. From 1998 to 2000, the annual harvest averaged 110 657 cubic metres. Timber from the Arrowsmith SBFEP is processed at mills located on Vancouver Island, mainly the southern portion, and the Lower Mainland.

Processing facilities

The South Island Forest District has the second largest concentration of mills in the province, behind the Vancouver Lower Mainland. The district is home to approximately 21 lumber mills, three log home manufacturers, two chip mills, three pulp mills, two paper mills, eight shake and shingle mills, and one veneer mill. From 1998 to 2000, the solid wood mills processed an average of about 5.5 million cubic metres of timber per year and employed over 2,500 people. The timber supplying these mills comes from numerous sources throughout the British Columbia coast.

The three pulp and two paper mills operating in the Arrowsmith TSA are the Pacifica Papers Inc. pulp and paper mill located in Port Alberni, the Pope and Talbot Ltd. pulp mill located at Cedar, and the Norske Skog Canada Ltd. pulp and paper mill located at Crofton. From 1998 to 2000, the pulp mills employed over 2,400 people and processed about 2.1 million bone dry units of wood chips in the production of 1.7 million metric tonnes of pulp. As with the solid wood mills, the fibre processed at these mills originates from numerous sources in addition to the Arrowsmith TSA.

7.2.4 Forestry sector employment and employment coefficients

The preceding harvesting and employment information is used to develop employment coefficients, which are used to project future employment levels in the forestry sector. For this purpose, the forestry sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment including falling, log salvage, log scaling, log transport, harvest planning and administration;
- silviculture employment such as planting, surveying and other basic and intensive silviculture activities, such as spacing, fertilizing and pruning*; and
- primary timber processing employment at lumber mills, veneer and plywood mills, shake and shingle mills, chip mills, log home mills and pulp and paper mills.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the first sub-sector that would be affected by a change in the AAC. The predominant silvicultural system used in the Arrowsmith TSA is clearcutting using ground-based, cable, and helicopter yarding systems. The active logging season can run all year, but varies by company and weather conditions. Local residents account for an average of about 25-30% of the harvesting workforce.

The silviculture sub-sector is perhaps the least tied to the current level of harvest, given that silviculture activities are ongoing for as much as 10-15 years following harvesting. Basic silviculture consists of pre- and post-harvest surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced, or intensive silviculture includes spacing, fertilizing, and pruning. In the TSA, major licensees are responsible for basic silviculture on areas harvested under major licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is completed by silviculture contractors.

Employment data compiled for this timber supply review indicate that from 1998 to 2000, the average annual TSA harvest of about 290 031 cubic metres supported about 119 person-years of direct harvesting and silviculture employment across the province. About 81% of this workforce reside within the Arrowsmith TSA.

Processing employment

The South Island Forest District, which includes the Arrowsmith TSA, has a large processing sector that is part of a complex web of coastal timber flows, trading and log sales. The Arrowsmith TSA is a relatively small management unit within the region and supplies mills on Vancouver Island and the Lower Mainland.

Employment data compiled for this timber supply review indicate that, from 1998 to 2000, the TSA harvest of about 290 031 cubic metres per year supported approximately 168 person-years of direct processing employment across the province. About 62% of this processing employment are associated with milling operations within the Arrowsmith TSA. The TSA timber supply provides up to about 5% of the forest district's requirements.

Forest Service employment

The South Island Forest District office located in Port Alberni administers the Arrowsmith TSA. Currently, approximately 70 people work in the forest district office. Forest Service staff are involved in administration, enforcement of government policy, and SBFEP-related planning for the South Island Forest District including the Arrowsmith TSA.

Arrowsmith TSA employment coefficients

Table 13 summarizes the employment supported by the 1998–2000 average harvest in the Arrowsmith TSA and the corresponding employment coefficients. These coefficients have been calculated for the TSA and province to highlight the level of forestry activity within the Arrowsmith TSA and to identify the contribution that the Arrowsmith TSA's forestry sector makes to the provincial economy. The two employment levels are defined as follows:

- TSA employment and employment coefficients, which comprise residents of the Arrowsmith TSA who are employed in the forestry sector within the Arrowsmith TSA and who rely on the Arrowsmith TSA timber supply; and
- Provincial employment and employment coefficients, which comprise all forestry sector employment in the province that relies on the Arrowsmith TSA timber supply, including both residents of the Arrowsmith TSA and those who live elsewhere.

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Employment is divided into direct, indirect and induced components; the sum of the components is the total impact. The coefficients are expressed as the number of full-time jobs, or person-years, per 1000 cubic metres of timber harvested. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Finance and Corporate Relations.

More detailed information regarding employment coefficients and multipliers is presented in Appendix B, "Socio-Economic Analysis Background Information."

Table 13. Arrowsmith TSA employment and employment coefficients,[7] average 1998–2000

Forest industry activity	TSA employment (person-years)	TSA coefficients (person-years /'000s m³)	Provincial employment (person-years)	Provincial coefficients (person-years /'000s m³)
Harvesting	90	0.31	107	0.37
Silviculture	6	0.02	12	0.04
Processing	104	0.36	168	0.58
Total direct	200	0.69	287	0.99
Indirect + induced	130	0.45	353	1.22
Total employment	330	1.14	640	2.21

Note: Employment estimates are reported in person-years based on average 1998–2000 employment levels and the average 1998-2000 Arrowsmith TSA harvest of 290 031 cubic metres per year.

(7) Other employment coefficients may be found in other documents for the same or similar areas. A difference in ratios can occur for several reasons, such as using different sources of employment data and rounding of estimates, dividing employment by a different harvest level, using a different definition of a full-time position and changing the definition of forestry sub-sectors. However, the size of impacts associated with a timber supply change should illustrate similar effects.

7.2.5 Arrowsmith TSA employment income

From 1998 to 2000, the average income for forestry sector employees associated with the Arrowsmith TSA was about $47,640, based on average provincial income levels for logging and forestry services, solid wood manufacturing and pulp and paper manufacturing (see Appendix B). Average income for indirect and induced sector employees was $30,800. From 1998 to 2000, the total direct income associated with the forestry sector in the Arrowsmith TSA averaged $13.7 million per year and total income for indirect and induced employment averaged $10.9 million per year (incomes are reported in 1999 dollar values). Combined, total employment income associated with forest industry activity related to the Arrowsmith TSA averaged $24.6 million per year. Table 14 shows income levels, average wages and salaries, and total income per 1000 cubic metres of harvested timber.

Table 14. Average direct and indirect and induced incomes and total employment income, 1998–2000

	Average wage (1998 dollar value)	Total income ($ millions)	Total income ($/'000s m^3)
Direct	47,640	13.7	47,100
Indirect + induced	30,800	10.9	37,500
Total income		24.6	84,600

Statistics Canada Labour Force Survey, Earnings and Employment Trends, British Columbia Industrial Comparison, Average Weekly Wage Rates. See British Columbia Stats at www.bcstats.gov.bc.ca.

7.2.6 Provincial government revenues

The provincial government receives various taxes and other revenues from the forest industry. The forest industry pays stumpage, royalties and rents to the provincial government for the rights to timber and its use, and other industry operating taxes such as corporate income, property, and sales taxes. The provincial and federal governments also receive revenues from forestry employees directly through income taxes.

From 1998 to 2000, forest industry activity in the Arrowsmith TSA provided an average of about $7.8 million in annual stumpage, royalty and rent payments to the provincial government. Other government revenues from forest industry taxes accounted for $2.6 million per year. Total employment supported by the Arrowsmith TSA harvest generated total annual provincial and federal income taxes worth $5.4 million. About one-third of the total income tax, or $1.8 million per year goes to the provincial government. Table 15 shows average annual provincial government revenues for 1998-2000.

Table 15. Average annual provincial government revenues, 1998-2000

	Average annual revenue 1998–2000 ($1999 millions)	Average revenue ($/'000s m^3)
Stumpage, rents and royalties	7.8	27,400
Industry taxes	2.6	9,037
Provincial income tax	1.8	6,182
Total provincial government revenues	12.2	42,619

Sources: Ministry of Forests, Revenue Branch, PricewaterhouseCoopers, Revenue Canada

7 Socio-Economic Analysis

7.3 Socio-economic implications of the base case harvest forecast

The socio-economic analysis focuses on harvest level changes in the short- to mid-term of 10–30 years from now and considers:

- the implications of alternative harvest levels for both the Arrowsmith TSA and the province;
- possible impacts on communities within the TSA;
- timber requirements of processing facilities within the Arrowsmith TSA; and
- regional timber supply implications.

The socio-economic analysis considers average levels of forest industry related activity that the base case harvest forecast could support. Impacts associated with future harvest levels are calculated using employment, income and revenue coefficients (per 1000 cubic metres). This method assumes that the current role of the forest industry in the provincial economy and labour productivity will not change. For example, employment levels in the future can be predicted based on today's relationship between employment and the volume of timber harvested and processed. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment will remain constant and that the types and proportions of wood products manufactured will remain the same.

While this method is reasonably accurate for short-term forecasts (within the next five years), employment coefficients 20 years from now may differ greatly due to changes in market conditions, timber processing technologies, etc. The analysis indicates the magnitude of impacts to employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

7.3.1 Short- and long-term implications of alternative harvest levels

Employment and income impacts in the Arrowsmith TSA

Arrowsmith TSA employment and income impacts focus on those workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as are those supported by Arrowsmith TSA timber processed at mills outside the forest district. Table 16 indicates the employment and income that the current AAC could support if fully harvested and processed, the activity related to recent harvest levels, and that related to the base case harvest forecast.

The current AAC of 400 000 cubic metres, if fully harvested, can support about 275 person-years of direct employment and a further 180 person-years of indirect and induced employment within the TSA. This level of employment would result in about $18.6 million in total employment income per year.

From 1998 to 2000, the average harvest level was 290 031 cubic metres per year, which is 27% below the current AAC. The current undercut indicates that recent forestry activity has room for expansion; however, cut control was met during the previous cut-control period and there is no indication that the full allocation of timber will not be harvested during this cut-control period. Current employment may not be at its full potential if companies have adjusted their workforce to the lower harvest levels. Data collected for this report indicates that some companies appear to have kept their full compliment of workers and others have not. This trend is apparent by examining employment coefficients for each company. Companies may react to a change in the timber supply in a number of ways including reducing its workforce, reducing the work year while retaining the same number of workers, or may provide retirement incentives.

A reduction in the timber supply to 357 000 cubic metres per year may not result in as large a reduction to employment as would have been expected if the full AAC were being harvested. The forecast reduction in the timber supply could lead to a reduction in direct employment of 30 person-years from full employment levels associated with the AAC. However, direct forest sector employment, notably in the harvesting sub-sector is constantly subject to fluctuating harvest rates and subsequently employment levels. A reduction in the timber supply will reduce the total employment potential in the TSA and will affect those workers who are part-time or temporary. Attrition through retirement may mitigate any employment impacts affecting the younger component of the labour force.

Provincial employment and income impacts

Provincial employment and income impacts include all the activity supported by the Arrowsmith TSA harvest, regardless of processing location and place of residence.

The current AAC of 400 000 cubic metres can support about 396 person-years of direct employment and a further 488 person-years of indirect and induced employment across the province. This level of employment results in $33.9 million in annual total provincial employment income.

A reduction in the timber supply to 357 000 cubic metres per year could reduce provincial employment by 40 person-years (including TSA employment) from full employment levels. As discussed in the previous section, the recent low harvest levels may indicate that some companies have at least temporarily reduced their workforce, which would reduce the impacts on those who are currently working. Those expecting to return to work, however, would still be negatively impacted even if not currently working.

7 Socio-Economic Analysis

Table 16. Arrowsmith TSA socio-economic impacts: base case harvest forecast

			Base case harvest forecast	
	1998-2000 average harvest rate	Current AAC (m^3/yr)	Short term Decade 1 (m^3/yr)	Medium term Decade 4 (m^3/yr)
Harvest level (1998-2000 average)	290 031	—	—	—
Timber supply (current AAC or forecast timber supply)	400 000	400 000	357 000	263 000
Difference from current AAC	– 109 969	0	– 43 000	– 137 000
Arrowsmith TSA				
Employment		(person-years)		
Direct	200	275	245	181
Indirect + induced	130	180	160	118
Total	330	455	405	299
Range[a] of employment gain (loss) to AAC		110-125	(43-48)	(140-155)
Employment income		($1999 million per year)		
Direct	9.5	13.1	11.7	8.6
Indirect + induced	4.0	5.5	4.9	3.6
Total	13.5	18.6	16.6	12.2
Range of income gain (loss) to current AAC		4.6-5.1	(1.8-2.0)	(5.8-6.4)
Province[b]				
Employment		(person-years)		
Direct	288	396	355	260
Indirect + induced	352	488	435	320
Total	640	884	790	580
Range of employment gain (loss) to AAC		210-244	(83-96)	(263-303)
Employment income		($1999 million per year)		
Direct	13.7	18.9	16.9	12.4
Indirect + Induced	10.9	15.0	13.4	9.9
Total	24.6	33.9	30.3	22.3
Range of income gain (loss) to current AAC		8.1-9.3	(3.1-3.6)	(10.1-11.6)
Provincial government revenues		($1999 million per year)		
Stumpage and related payments	8.0	11.0	9.8	7.2
Forest industry taxes	2.6	3.6	3.2	2.4
Employee income taxes	1.8	2.5	2.2	1.6
Total	12.4	17.1	15.2	11.2
Revenue gain (reduction) to current AAC		4.7	(1.9)	(5.9)

(a) Gains or losses are based on the difference between the current allowable annual cut and the current average timber harvest or the projected future timber supply. The ranges for employment and income changes consider employment insurance and other social assistance programs that give temporary short-term income to unemployed or displaced workers. The range's upper limit assumes that all those who are unemployed or displaced will leave the TSA to seek opportunities elsewhere and will no longer spend their income locally, thus imparting a higher impact on the local economy than if they had not left. The range's lower limit assumes that employment insurance and other social assistance payments to unemployed or displaced workers will temporarily encourage them not to leave the community, thus reducing the induced impacts of a lower harvest level. The actual impacts of changes in harvest levels on employment and incomes will likely fall within the specified ranges. The converse of this applies for harvest increases. More details are in Appendix B.

(b) TSA employment and income estimates are included in the provincial employment and income estimates.

Provincial government revenue impacts

Provincial government revenues from the forest industry include stumpage, royalties and rent payments; other taxes such as logging, corporate income, sales, property and electricity taxes; and income taxes from direct, indirect and induced employees. Under the existing tax and stumpage regimes, the current AAC of 400 000 cubic metres, if fully harvested, would provide on average about $17.1 million annually to the provincial government. A reduction in the timber supply to 357 000 cubic metres could reduce potential annual revenues from the TSA by about $1.9 million.

7.3.2 Community-level impacts

The impacts related to changes in the timber supply can affect the socio-economic environment of a community. A reduction in employment and income could affect various socio-economic conditions in communities: for example, population growth rates, the size of the labour force, economic development opportunities and government-funded services. These changes would have a greater effect on an economy dependent on a single industry than on one that is more diversified and experiencing growth in other sectors.

The Arrowsmith TSA is a large and diverse region comprised of a number of areas with very different industry dependencies. The Victoria region is highly dependent on the public sector; Lake Cowichan, Ladysmith and Port Alberni areas are dependent on the forestry sector; and the Parksville-Qualicum area is highly dependent on transfer incomes such as pension and other investment income. Given this wide ranging economic structure, forecast reductions to the timber supply of the Arrowsmith TSA will not lead to any substantial impacts to the region's economic stability, but any impacts that do occur would focus on areas where the forest industry is dominant. A strong regional economy does not minimize the potential impact on individuals who may find they have difficulty finding work in their chosen profession.

Individuals who lose their jobs are not only subject to economic concerns, but also physical and emotional difficulty while in transition to another job or profession. Physical and emotional effects on individual workers vary depending on age, education, future job opportunities, and various existing physical and emotional characteristics. Lee[8] notes that unemployment has been associated with a number of physical and emotional, or stress related symptoms. However, the loss of one's job is only one of many factors associated with illness, although job loss often precipitates physical and/or mental breakdown. A 1996 discussion paper by the Canadian Public Health Association[9] found that the literature examining the health impact of unemployment indicates a strong relationship between unemployment and ill health. This highlights the importance of a quick transition to new opportunities for displaced workers. How pressures related to job loss and uncertainty will affect residents of the Arrowsmith TSA is impossible to predict, yet these possible emotional and physical reactions should be anticipated.

(8) Lee, Robert, 1993. "Effects of Federal Timber Sales Reductions on Workers, Families, Communities, and Social Services," in Building Toward a Balances Solution: Position Papers on Northwest Forestry Issues, compiled by the Northwest Forestry Research Council.

(9) Canadian Public Health Assoc. (1996). 1996 Discussion Paper on the health impact of unemployment.

7.3.3 Nature, production capabilities and timber requirements of processing facilities

The current milling structure of the Arrowsmith TSA consists of about 21 sawmills, three pulp mills, two paper mills, a veneer mill, chip mills, and shake and shingle mills. From 1998 to 2000, the average annual volume of logs processed by local solid wood mills was about 5.5 million cubic metres and the pulp mills processed an average of 2.1 million BDUs of chips.

The initial reduction forecast in the timber supply analysis is not sufficient on its own to negatively affect the district's current milling structure. However, the TSA is part of a timber supply network in which cumulative changes could affect local processing. Any reduction to the Arrowsmith TSA timber supply invariably means that the TSA will be supporting fewer people at the mills that process the TSA's timber. Subsequently, mills will have to find other sources of timber to maintain existing production levels.

7.3.4 Regional timber supply issues

The regional timber supply is an important consideration when examining potential future impacts associated with timber supply changes. The Vancouver Forest Region supplies timber to mills throughout the southwestern portion of the province. From 1998 to 2000, solid wood mills in the Vancouver forest region processed an average of 17.5 million cubic metres of timber per year. Timber from the Arrowsmith TSA accounts for about 2% of the region's consumption.

Over the next 25 years, timber supply forecasts indicate that the average annual harvest in the Vancouver Forest Region could decline by up to 20%, or 4 million cubic metres.[10] Given a change of this size, the current processing structure of southwestern British Columbia could not be maintained. The South Island Forest District has a large processing sector that relies on the coastal timber supply. Any future changes to this supply will put pressure on the district's milling structure.

7.4 Summary

The South Island Forest District, of which the Arrowsmith TSA is a part, is an economically diverse area made up of a number of distinct regions. The northern portion of the district is highly dependent on the retirement community and its transfer income; the Port Alberni-Nanaimo-Duncan areas are dependent on the forestry sector as a source of employment; and the southern portion is most dependent on the public sector as its source of employment and income.

The current AAC of 400 000 cubic metres, if fully harvested and processed, can support about 396 person-years of direct forestry employment and a further 488 person-years of indirect and induced employment across the province. Residents of the Arrowsmith TSA account for about 69% of the direct employment. The employment income associated with this direct, indirect and induced employment would be about $33.9 million per year.

The average harvest from 1998 to 2000 was 290 031 cubic metres per year although licensees achieved the previous cut-control requirements from 1993 to 1997.

The base case harvest forecast indicates an immediate 11% reduction in the timber supply to a harvest level of 357 000 cubic metres per year. This change could lead to a reduction in direct forestry sector employment of about 40 person-years from full employment levels. Those workers who may be affected by this reduction would be those who are part of the marginal labour force and who are generally the ones experiencing more sporadic periods of work.

Based on the average 1998–2000 harvest, the provincial government currently collects about $12.4 million per year in stumpage and related payments, other industry taxes and provincial income taxes. Fully harvesting the apportioned volumes of timber in the Arrowsmith TSA could result in annual government revenues of up to $17.1 million, the majority of which would be stumpage and related payments.

(10) This reduction is based on moving from the current Vancouver Forest Region timber supply of about 20 million cubic metres per year to 16 million cubic metres. These estimates may change as new information is incorporated into each timber supply review.

8 References

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9 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Commercial thinning	A silviculture treatment that 'thins' out an overstocked stand by removing trees that are large enough to be sold as products such as poles or fence posts (see also, **Juvenile spacing**). It is carried out to improve the health and growth rate of the remaining crop trees.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees shed their leaves annually and commonly have broad-leaves.
Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Employment multiplier	An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

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Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest Practices Code	Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

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Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Old seral	Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.
Partition	A portion of the AAC that is attributable to certain types of timber and/or terrain.
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

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Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

In May of 2000 a data package for the Arrowsmith Timber Supply Area timber supply review was released for public review. As a result of public input a number of data and management assumptions have been revised. This appendix presents the revised data package used to produce the timber supply analysis.

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Arrowsmith TSA timber supply analysis. This information represents current forest management in the area. Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix. The purpose of the timber supply review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Inventory Information

Table A-1. lists the inventories that will be used to define the timber harvesting land base, and to model forest management activities.

Table A-1. Inventory information

Data	Source	Vintage	Update	Scale
Forest cover	Ministry of Forests (MoF)	1988-1992	1999	1:20,000
Ungulate winter ranges[a]	Ministry of Environment, Lands and Parks (MELP)	1998	1999	1:20,000
Biogeoclimatic classification[a]	MELP	1994		1:20,000
ESAs mapping	MoF	1993		
Operability mapping	MoF	1988 1994		1:20,000
Recreation inventory	MoF	1993		1:20,000
Landscape inventory	MoF	1991-1997		1:20,000
VQO and RVQC management zones overlay[a]	MoF	1998		1:20,000
VQO and VQC overlay[a]	MoF	1998		1:20,000
Community watersheds[a]	MELP	1996	1999	1:20,000
Clayoquot Sound land-use decision boundary[a]	Provincial government	1993		1:20,000
Clayoquot Sound watersheds and sub-basins[a]	MoF	1997		1:20,000
Escalante River watershed sub-basins[a]	Interfor	1999		1:20,000
Draft landscape unit boundaries[a]	MoF and MELP	1997	1999	1:20,000
Resource management zones (VILUP)[a]	Land Use Coordination Office (LUCO)	1997		1:20,000

(a) Non-standard data

Data source and comments:

An inventory audit of the Arrowsmith TSA completed by the Forest Service in 1999 showed that the inventory estimate of volume in mature stands (over 60 years old) was approximately 4% above the estimate derived from ground samples. This small apparent over estimation was in inventory volumes was not statistically significant. These results indicate that the volume estimates used in TSR 1 were adequate and not a notable source of uncertainty.

A.2Zone and Analysis Unit Definition

A.2.1 Management zones and tracking of multiple objectives (grouping)

Management zones differentiate areas with distinct management emphasis and homogenous forest cover. For example, a zone may be based on a harvesting system, silviculture system, visual quality objective or wildlife consideration

Table A-2. Objectives to be tracked

Group	Objectives	Comments
1	Clayoquot portion *versus* remainder of Arrowsmith TSA	Separate analysis for Clayoquot Sound portion of the Arrowsmith TSA *versus* the remainder of the Arrowsmith TSA.
2	Timber harvesting land base by draft landscape unit or sub-basin	Reporting purposes. Crown forested, operable area where timber harvesting may occur. Provides an assessment of the timber harvesting land base.
3	All forested land by draft landscape unit or sub-basin	Reporting purposes. Provides an assessment of the total forest by draft landscape unit or sub-basin.
4	Scenery (excluding Clayoquot Sound portion of the Arrowsmith TSA)	Application of VQOs and RVQCs by draft landscape unit that fall within zone 1 and zone 2 areas. Zone 1 areas are managed at the midpoint of the per cent alteration for a given VQO or RVQC. Zone 2 areas are managed at the upper point of the per cent alteration for a given VQO or RVQC. VQOs & RVQCs include: retention, partial retention and modification.
5	Integrated resource management areas (IRM) (excluding Clayoquot Sound portion of the Arrowsmith TSA)	Application of adjacency criteria by draft landscape unit. Crown, forested, operable area where harvesting operations are not otherwise constrained by visual resources or wildlife habitat.
6	Distribution of harvest (excluding Clayoquot Sound portion of the Arrowsmith TSA)	Distribution of harvest between eastern and western divisions. The west division is made up of the Barkley TSB, and the east division is made up of the Cowichan and Nanaimo supply blocks.
7	Fragmentation of land base (excluding Clayoquot Sound portion of the Arrowsmith TSA)	Application of criteria for areas of crown forest within the east and west division of the Arrowsmith TSA that are fragmented.
8	Deciduous component of the harvest (excluding Clayoquot Sound portion of the Arrowsmith TSA)	Reporting purposes. Provides an assessment of the harvest level for deciduous stands leading in red alder.
9	Vancouver Island Summary Land Use Plan	Application of resource management objectives and strategies for areas of crown forest that fall within the three zone types — special management zone, enhanced management zone, and general management zone.
10	Community watersheds	Application of rate of harvest for community watersheds — no more than 5% disturbance in five years.
11	Coastal watershed assessments	Application of the rate of harvest in terms of equivalent clearcut area (ECA) for those watersheds that have had a coastal watershed assessment. Hydrological recovery is modelled as per Table A2.2 of the *Coastal Watershed Assessment Procedure Guidebook* (CWAP), Second Edition April 1999.
12	Unconventional harvest	Reporting purposes. Provides an assessment of the harvest level attributable to unconventional harvesting methods such as long-line and helicopter systems.

A.2.2 Analysis units

An analysis unit represents a combination of stands dominated by specific tree species or silvicultural regime with a specific timber growing capability — as indicated by the inventory type group and site index in the forest inventory file. Each analysis unit is assigned its own timber volume projections (yield tables) for existing and future stands.

Yield tables for existing natural stands are derived using the variable density yield projection (VDYP) growth and yield model. Yield tables for recent plantations and future stands are derived using the table interpolation program for stand yields (TIPSY).

A.2Zone and Analysis Unit Definition

Table A-3. Definition of analysis units

Analysis unit	Area of timber harvesting land base (hectares)	Criteria		
		Inventory type groups	Site index range[a]	Site class
Fir[b] — East Division	4 896	1-8	> 32	Good
Fir[b] — West Division	1 235	1-8	> 32	Good
Fir[b] — East Division	8 891	1-8	26-32	Medium
Fir[b] — West Division	1 548	1-8	26-32	Medium
Fir — East Division	7 061	1-8	< 26	Poor
Fir — West Division	797	1-8	< 26	Poor
Cedar — East Division	268	9-11	> = 17	Good/medium
Cedar — West Division	6 334	9-11	> = 17	Good/medium
Cedar — East Division	103	9-11	< 17	Poor
Cedar — West Division	8 491	9-11	< 17	Poor
Hemlock/balsam (true fir) — East Division	803	12-20	> = 22	Good/medium
Hemlock/balsam (true fir) — West Division	8 271	12-20	> = 22	Good/medium
Hemlock/balsam (true fir) — East Division	524	12-20	< 22	Poor
Hemlock/balsam (true fir) — East Division	8 295	12-20	< 22	Poor
Spruce — East Division	1	21-26	> = 22	Good/medium
Spruce — West Division	130	21-26	> = 22	Good/medium
Spruce — West Division[c]	135	21-26	< 22	Poor
Red alder (red alder leading stands that are = 50% deciduous by gross stand volume)	1 931	37-38, greater than 50% alder on volume basis	All	All sites
Other red alder (red alder leading stands that are < 50% deciduous by gross stand volume)	64	37-38, less than 50% alder on volume basis	All	All sites
Other stands (coniferous and deciduous)	317	27-36, 39-42	All	All sites

(a) Site index range reference age is 50 years.

(b) Portions of these analysis units are commercially thinned.

(c) There is no spruce poor in the East Division.

A.3Definition of the Timber Harvesting Land Base

A.3.1 Land not administered by the British Columbia Forest Service for timber supply

Ownership codes are generally used to identify whether the land can be considered to contribute to timber supply. Ownership codes 62C, 61C and 69C indicate Crown land in a forest management unit, Crown land in UREPs and miscellaneous reserves, respectively. These are generally the only ownership codes which are considered to contribute to timber supply. Ownership code 70N, timber licence land in a TSA, is considered under Section A.3.14. Areas with other ownership codes will be removed from the land base considered for timber supply. This includes woodlot license areas since their AACs are determined independently from the timber supply review process.

A.3.2 Land classified as non-forest

Type identity 6 areas, such as alpine, lakes, rocks etc., and type identity 8 areas (untyped) are removed from the land base considered for timber supply.

A.3.3 Non-commercial cover

Type identity 5 represents those areas which were inventoried to have non-commercial brush species growing on them. These areas are considered to be unlikely sites for timber production.

A.3.4 Environmentally sensitive areas

Some forest lands are environmentally sensitive and/or significantly valuable for other resources. These areas are identified and delineated during a forest inventory and are called environmentally sensitive areas (ESAs). The ESA system uses the following categories: soil (Es), forest regeneration problems (Ep), snow avalanche (Ea), recreation (Er), wildlife (Ew), water (Eh) and fisheries (fisheries symbols). With the exception of wildlife, avalanche and fisheries, two ESA categories are recognized: high and moderately sensitive.

As noted previously it is important to ensure that only areas in which harvesting is expected to take place are allowed to contribute to the timber harvesting land base. Thus it is important to separate the areas in which some limited harvesting will take place and those areas which are unavailable. The table below indicates the proportions of areas in the various ESA categories that are unavailable for timber harvesting.

Table A-4. Description of environmentally sensitive areas

ESA category	ESA code	ESA descriptor	Reduction per cent (%)
Soil sensitivity (not mapsheets 092G001 or 092B091). Environmentally sensitive areas for soils are on the FIP file planning cell level.	S001 S002	Es1 Es2	90 20
Soil sensitivity (mapsheets 092G001, 092B091).	Es1 Es2		90 20
Ungulate winter ranges Ew1, Ew2 and Ewz, and wildlife other than ungulate winter ranges.		Ew1 Ew2 Ewz	100 50 Range from 20-70
Regeneration	Ep1 Ep2		90 50
High avalanche hazard	Ea1 and Ea2		100

A.3.5 Areas with high recreation values

Recreation areas such as campgrounds, trails and lookout sites are identified in the inventory file through the recreation feature significance and recreation management class variables. Areas with a recreation features significance code of "A" or "B" and a recreation management class code of "0" are areas with very high and high recreational, educational, scientific or heritage value that are more appropriately managed exclusively for recreational values. Areas with a recreation features significance code of "A" or "B" and a recreation management class code of "1" are areas with high recreational, educational, scientific or heritage value requiring special management consideration to protect or maintain their values. The amounts that the timber harvesting land base will be reduced for areas with very high and high recreation value are listed in the table below.

Table A-5. Description of areas with high recreation values

Feature significance	Management class	Reduction per cent (%)
A or B	0	100
A or B	1	50
C	1	10[a]

(a) Reduction percentage applied only to those C1 polygons that do not have a VQO or RVQC.

A.3.6 Areas considered inoperable

Operability and inoperability codes are generally used to describe the presence or absence of physical barriers or limitations to harvesting, appropriate logging methods (e.g., cable), and the merchantability of stands.

Areas defined as inoperable are identified in the inventory file under the "OPERABLE" label by "I" (inoperable) and "X" (uneconomic) field codes. The operable areas are identified in the inventory file under the "OPERABLE" label by "G" (operable ground based), "U" (operable long line) and "H" (operable helicopter or water based) field codes. Areas that are identified by an activity code "L" (logged) in the activity layer will remain in the inventory regardless of its operability coding.

Table A-6. Description of inoperable areas

Inventory description	Code	Reduction per cent (%)
Operable — ground based	G	0
Operable — long line	U	0
Operable — helicopter/water based	H	0
Marginal	X	0
Inoperable	I	100

Data source and comments:

There is no operability netdown for the area covering the former Duncan Forest District (district = 'F'), therefore the operability coding is ignored in the netdown process for Duncan. Other land reductions, such as low site, ESAs, etc. are considered sufficient to account for operability in that area.

A.3 Definition of the Timber Harvesting Land Base

A.3.7 Sites with low timber growing potential

Sites may have low productivity either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.), or because they are not fully occupied by commercial tree species. As these stands are not considered to be harvestable, they need to be identified and removed from consideration for the timber harvesting land base.

Table A-7. Description of sites with low timber growing potential

Species	Inventory type group	Volume (m^3/hectare)	Reduction per cent (%)
Red alder (Dr)	37-38 with greater than or equal to 50% deciduous by gross stand volume	< 200 m^3/hectare or greater than 70 years of age	100
Conifers, other red alder and other stands	1-34 37-38 — with less than 50% deciduous by gross stand volume	West division < 400 m^3/hectare East division < 300 m^3/hectare and Any stand projected to never achieve a height of 19.5 metres or greater and never to achieve above volumes per hectare by 150 years.	100

A.3.8 Unmerchantable forest types

Problem forest types (PFT) are stands that are physically operable and exceed low site criteria but are not currently utilized or have marginal merchantability. These types are wholly excluded from the timber harvesting land base.

Table A-8. Unmerchantable forest types criteria

Species	Inventory type groups	Reduction per cent (%)
Deciduous other than red alder	35, 36, 39–42	100

A.3Definition of the Timber Harvesting Land Base

A.3.9 Roads, trails and landings

Separate estimates are made to reflect the loss in productive forest land due to existing and future roads, trails and landings (RTL). Existing RTL estimates are applied as reductions to the current productive forest considered available for harvesting, and future RTL reductions are applied after stands are harvested for the first time in the simulation model. Estimates can be applied as the amount or percentages of area to be removed from specified age classes and zones. Estimates account only for the area that will be permanently removed from the timber harvesting land base.

Table A-9. Estimates for existing and future roads, trails, and landings

Location	Age class (years)	Road width (metres)	Reduction area (hectares or per cent)
Existing RTLs			
All roads (all roads are given a 5 metre GIS buffer from the centre-line and then netted out of the timber harvesting land base)		10	100%
Future RTLs			
All commercial thinning analysis units. East division.	30–60		3.6%
All other analysis units within conventional operable areas. East division.	> 80		4%
All analysis units within conventional operable areas. West division.	> 80		6.1%

A.3.10 Wildlife tree retention

The *Landscape Unit Planning Guide* recommends retention of wildlife tree patches (WTPs) for providing stand structure over time. The *Biodiversity Guidebook* also indicates that wildlife tree patches (group reserves) larger than two hectares in size within a cutblock boundary can contribute to old-seral stage forest requirements at the landscape level.

Wildlife tree patch retention targets were developed by the Ministry of Forests and the Ministry of Environment, Lands and Parks staff using Tables 20a and 20b of the *Biodiversity Guidebook* (equivalent to Tables A3.1. and A3.2 in the *Landscape Unit Planning Guide)* and released by the District Manager on December 8, 1997, as a *District Policy* (DSI-01). This policy specifies for each draft landscape unit two wildlife tree patch retention targets — one for when landscape units are in place (20a) and one for when they are not (20b). The district targets using Table 20a have been used in this analysis because forest cover requirements for landscape-unit biodiversity are modelled in the base case.

The wildlife tree patch retention targets have been reduced by 75% as per the assumption used in the *Forest Practices Code Timber Supply Analysis*, February 1996, that 75% of the wildlife tree patch requirements will be met by riparian reserves and other areas outside of the timber harvesting land base. The percentage of the timber harvesting land base required for wildlife tree patches ranges between 0.25 to 4% by landscape unit using this approach for the remaining 25% of the WTP requirements.

Table A-10. Reductions to reflect area retention in cutblocks for wildlife tree patches

Landscape unit	Biogeoclimatic ecosystem classification (BEC) subzone	Wildlife tree patch retention targets (%)	Residual area estimate on the timber harvesting land base (%)
Cameron	CWH	11	2.75
	MH	6	1.50
Chemainus	CDF	9	2.25
	CWH	13	3.25
	MH	7	1.75
China	CWH	11	2.75
	MH	6	1.50
Cowichan	CDF	10	2.50
	CWH	12	3.00
	MH	14	3.50
Effingham	CWH	3	0.75
	MH	1	0.25
Englishman	CDF	9	2.25
	CWH	7	1.75
Escalante	CWH	10	2.50
	MH	7	1.75
French Creek	CDF	9	2.25
	CWH	12	3.00
Gordon	CWH	10	2.50
	MH	3	0.75
Henderson	CWH	6	1.50
	MH	0	0
Koksilah	CDF	9	2.25
	CWH	13	3.25
Little Qualicum	CDF	11	2.75
	CWH	8	2.00
	MH	10	2.50
Loss	CWH	10	2.50
	MH	5	1.25
Maggie	CWH	10	2.50
Millstone	CDF	13	3.25
	CWH	11	2.75
Nahmint	CWH	4	1.00
	MH	0	0
Nanaimo	CDF	9	2.25
	CWH	12	3.00
	MH	0	0
Nanoose	CDF	9	2.25
	CWH	10	2.50

(continued)

Table A-10. Reductions to reflect area retention in cutblocks for wildlife tree patches (concluded)

Landscape unit	Biogeoclimatic ecosystem classification (BEC) subzone	Wildlife tree patch retention targets (%)	Residual area estimate on the timber harvesting land base (%)
Qualicum/Rosewall	CDF	12	3.00
	CWH	11	2.75
San Juan	CWH	10	2.50
	MH	4	1.00
Sarita	CWH	10	2.50
Shawnigan	CDF	9	2.25
	CWH	8	2.00
Sooke	CWH	9	2.25
Somass	CWH	14	3.50
	MH	13	3.25
Sproat	CWH	9	2.25
	MH	0	0
Toquart	CWH	4	1.00
	MH	0	0
Tugwell	CWH	14	3.50
	MH	1	0.25

Data source and comments:

It is uncertain whether wildlife tree patches (WTPs) are on average larger than two hectares within the Arrowsmith TSA. Two hectares is the minimum size requirement for WTPs to contribute to old-seral stage requirements at the landscape level, therefore, WTPs will not also contribute to OGMA's in the timber supply analysis.

A.3.11 Cultural heritage resource reductions

Cultural heritage values include traplines, and sites of archaeological or traditional use.

Most of the recorded cultural heritage sites are on the west coast of Vancouver Island and are located in close proximity to the coastline.

An area of potential cultural heritage resource features will be defined by the following criteria:

- age greater than 80 years;
- species composition minimum 20% Cw or Cy; and
- less than 200 metres from the ocean.

Within this area, a netdown of 7% will be applied.

A.3Definition of the Timber Harvesting Land Base

A.3.12 Riparian reserve zones and riparian management zones

Table A-11. indicates the land base reductions to be applied to represent reservation from harvest of areas immediately adjacent to streams, lakes and wetlands and within the prescribed riparian management zone.

Table A-11. Description riparian reserve zones and riparian management zones

Location	Reduction per cent (%)
Timber harvesting land base	9.0

Data source and comments:

To account for riparian reserve zones (RRZ), the timber harvesting land base will be reduced by 4.8%. This figure is based on a study of 92 coastal cutblocks completed in 1994 by Wild Stone Resources. The per cent area excluded from the timber harvesting land base is calculated by multiplying the specified reserve width for each stream class (from the *Riparian Management Area Guidebook*) by the lengths of stream of each class found on the cutblocks sampled, then dividing by the total area of cutblocks sampled. All stream and water features will be buffered using geographic information system (GIS). The per cent of the timber harvesting land base within these buffers will be compared with the above 4.8% reduction for riparian reserve zones.

The estimated reduction factor based on average stream density figures for the coast when using partial or selection harvesting systems in riparian management zone is 4.2% (source: *Riparian Management Area Guidebook*). In the Arrowsmith TSA current practice within the RMZs is characterized as a per cent area retention rather than per cent volume retention.

A.3.13 Exclusion of specific, geographically defined areas

Table A-12. Exclusion of specific, geographically defined areas

Identifying inventory variables				
Location	**Mapsheet**	**Polygons**	**Excluded area (hectares or percent)**	**Reason for exclusion**
Growth and yield plots T7-C24D-15	092B092	92	0.4	Active growth and yield plots
Growth and yield plots T7-C13B-016	092F036	233	0.4	Active growth and yield plots
Growth and yield plots G7-C16A-017 G7-C16A-013 G7-C16A-014	092F038	404	0.4	Active growth and yield plots
Growth and yield plots R7-C12A-G04	092F047	648	0.4	Active growth and yield plots
Bamfield community forest license pilot	092C038	All land classified as 62-C in Inventory Region '6', Inventory Compartment '13D' and forest cover polygon < 58 and > 71	100%	Area has been offered as a community forest pilot licence
Woodlot – 1903	092F003 092F004	2 and 3 452, 147, 141, 136, 132, 131, 127 17, 125, 5, 11, 461, 13, 474, 15, 471 461	100%	In the process of being awarded
Camper Creek TL T0057	092C058	All land classified as 62-C and 70-N	100%	Crown land (Timber Licence T0057) will be transferred from the Arrowsmith TSA to TFL 46 as part of the land exchange for the Nitnat Park lands once the entire TL is reverted.

A.3.14 Timber Licence reversions

Timber Licences are old tenure arrangements that give a licensee exclusive rights to harvest merchantable timber within the license area and do not contribute to the TSA allowable annual cut. Once these areas have been harvested, regenerated and attain free-growing status, the timber licence area reverts to British Columbia Forest Service (BCFS) jurisdiction. Accordingly, these areas are included in the timber harvesting land base after the first harvest and contribute to the TSA harvests in medium- to long-term timber supply.

A.3Definition of the Timber Harvesting Land Base

Timber Licence areas need to be accounted for from the time the stands have been harvested, and/or from the time the stands will be harvested. Time of harvest is used as the reference point so that impact of these harvests on forest cover requirements is given full consideration in the timber supply analysis. In some cases stands that have been harvested and legally reverted have not had the necessary ownership change on the inventory file (e.g., change from 70-N to 62-C). These reversions are included in the following table.

Table A-13. Timber licence reversion schedule

Area of currently remaining timber licenses (hectares)	Location	Area of Timber Licences (TL) harvested (hectares) (year of harvest)
231	TLs inside Clayoquot Sound	Analysis of Clayoquot Sound only considers short-term harvest level. No plans to harvest within TLs for the next 5 years.
422	TLs outside Clayoquot Sound	Years 1-5 — 135 hectares The following 5 year periods until all TLs reverted — 360 hectares

Note: Stands coded as 70-N and less than age 50 years are assumed to be reverted.

A.4Forest Management Assumptions

A.4.1 Harvesting

A.4.1.1 Utilization levels

The utilization levels define the maximum stump height, minimum top diameter (inside bark) and minimum diameter at breast height (dbh) by species and are used in the analysis to calculate merchantable volume.

Table A-14. Utilization levels

Analysis unit	Utilization		
	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top diameter inside bark (dib) (cm)
All coniferous leading analysis units > 120 years	17.5	30	15
All coniferous leading analysis units < = 120 years	12.5	30	10
Alder > 45 years	17.5	30	15
Alder ≤ 45 years	12.5	30	10

A.4.1.2 Minimum harvestable age derivation

Analysis units are developed to achieve management objectives through groupings of stands with similar species associations, levels of productivity and growth characteristics. Minimum harvestable ages can be defined by a product goal or by harvest ages that achieve "optimal" stand level management. These are simply minimum criteria. While harvesting may occur in stands when the minimum requirements are achieved in order to meet forest level objectives (e.g., maintaining overall harvest levels for a short period of time or avoiding large inter-decadal changes in harvest levels), some stands may be not be harvested until well past "optimal" timber production ages when management of other resource values takes precedence (e.g., requirements for the retention of older forest).

The minimum harvestable age for stands in each analysis unit will be set to the greater of: (a) the estimated age for the stand to reach a required stand volume; (b) the age at which the stand achieves a specified minimum mean diameter at breast height (dbh); and, (c) the age at which the stand achieves 90% of maximum mean annual increment (MAI). In the case of the red alder analysis unit, this age must be less than 71 years.

A.4Forest Management Assumptions

Table A-15. Minimum harvestable age criteria

Analysis unit species	Site index	Minimum criteria			MAI (m³/hectare/year)
		Age (years)	Diameter (cm)	Volume (m³/hectare)	
East Division all species except alder analysis unit	All	N/A	25	300	90% of maximum MAI
West Division all species except alder analysis unit	All	N/A	30	400	90% of maximum MAI
Red alder analysis unit	All	≤ 70 years of age	N/A	200	90% of maximum MAI

A.4.1.3 Harvest scheduling priorities

For various reasons, it may be important to set priorities or minimum harvest levels on certain management zones or analysis units to reflect insect infestations, salvage operations or similar forest management activity. Table A-16. lists harvest priorities for the Arrowsmith TSA. In order to emulate the effects of natural disturbances on the Arrowsmith TSA, 115 hectares per year of old stands in inoperable areas are reverted to early seral stands. In the computer model, this is achieved by harvesting stands from inoperable areas, and assigning no volume to them.

Table A-16. Priorities for scheduling the harvest

Description	Management zone or location	Analysis unit	Period	Maximum volume/year to be harvest (m³/year)	Priority
Commercial thinning	East Division	Fd good and medium sites	1-2	23 700	1
Inoperable areas — natural disturbances	All	All	All	115 hectares per year (no volume associated with	1
Deciduous harvest	East and West Division[a]	37-38 and at least 50% deciduous by gross stand volume	Up to 2011	6 300	2

(a) The Clayoquot Sound portion of the Arrowsmith TSA is not included in this management zone, and is modelled separately from the remainder of the TSA.

A.4.1.4 Silvicultural systems

Table A-17. lists the silvicultural systems employed in the Arrowsmith TSA.

Table A-17. Silvicultural systems

Silvicultural system	Eligible analysis units or locations	Volume removed	Entry age	# of entries before final felling	Time before final felling
1. Even-aged silvicultural systems with retention	All analysis units except commercially thinned stands.		Minimum harvestable age or older.	N/A	Minimum harvestable age or older
2. Commercial thinning	Fd good and medium site analysis units East division only.	Minimum volume removed 130 m³/hectare. Maximum volume removed 38% of the stand volume. Minimum diameter 25 cm.	Age when volume removed criteria is met and a maximum of 20 years later (20-year window of thinning opportunity).	1	Minimum 20 years
Final entry	Fd good and medium site analysis units East division only.		At least 20 years after initial harvest.	N/A	N/A

Data source and comments:

A brief study of silvicultural prescriptions in the Arrowsmith TSA showed that an additional 8.4% of cutblock area (over and above riparian and wildlife tree patch requirements) is being retained as long term retention. Retention was modelled in the base case by assuming that one-half of this 8.4% (or 4.2%) is retained on the timber harvesting land base. A 4.2% reduction was made to all managed and natural stand volume tables.

A.4.2 Unsalvaged losses

The purpose of this section is to provide an estimate of average annual unsalvaged volume loss to insect and disease epidemics, fires, wind damage or other agents over the long term on the timber harvesting land base. The unsalvaged loss column reflects those areas in which the volume will not be recovered or salvaged.

Table A-18. Unsalvaged losses

Cause of loss	Total loss (m³/year)	Annual unsalvaged loss (m³/year)
Fire	1 000	1 000
Wind	2 500	1 000
Pests	0	0
Total	3 500	2 000

A.4Forest Management Assumptions

A.4.3 Silviculture

A.4.3.1 Regeneration activities in managed stands

Recent plantations and future stands will be grown on managed stand yield tables (MSYTs) produced using the Forest Service TIPSY growth and yield model. Table A-19 contains the inputs required to produce MSYTs for this analysis. Mixed species MSYTs will require a site index conversion equation to account for changes in site index when changing species on the same site. If reliable conversion equations cannot be found stands will assume to be regenerated to the same leading species currently occupying the site.

Table A-19. Regeneration assumptions by analysis unit

			OAFs		Method		Species (%)					Density (SPH)	
Analysis unit	Site quality	Regen delay	1	2	Type	%	Fd	Cw	Pw	Ba Bg	Hw	Initial	Final
Fd[a]	Good	2	15	See note[c]	Plant	100	75	10	5	10		1200	700
Fd[a]	Medium	2	15	See note[c]	Plant	100	70	10	10	10		1200	700
Fd[a]	Poor	3	15	See note[c]	Plant	100	70	10	10		10	1200	700
Cw	Good/ medium	2	15	5	Plant	100		58		12	30	1000	900
Cw	Poor	3	15	5	Plant Natural	85 15		70 100			30	1000	N/A
H/B/Sp	Good/ medium	2	15	5	Plant	100		20		10	70	1000	800
H/B/Sp	Poor	3	15	5	Plant Natural	85 15		20 15		15	80 70	1000	N/A
[b]Dr (the 10% being planted to red alder)	All	3	15	5	Plant	100	Dr–100%					1600	900 sph at 12 years
Other stands and other Dr	All	3	15	5	Plant	100	75	10		15		1400	N/A

(a) Those Douglas-fir stands < 80 years of age located in the west division of the Arrowsmith TSA within BEC variant CWHvh1, CWHvm1, or CHWvm2 are assumed to be off-site and will be regenerated as per the H/B/Sp analysis units after the first harvest.

(b) In implementing the Vancouver Forest Region red alder strategy, in 1999 and in the next four years, 20 hectares a year of red alder will be planted in the Arrowsmith TSA. For analysis purposes, 10% of the red alder analysis unit will be reforested back to red alder.

(c) Future regenerated Douglas-fir stands have an OAF 2 of 10%. Existing regenerated stands of Douglas-fir stands (between 1-50 years of age) have an OAF 2 factor of 12.5%

A.4.3.2 Immature plantation history

The purpose of this section is to identify areas of existing immature forest where the density (stems per hectare) was controlled and therefore should be assigned to a managed stand yield curve (TIPSY).

Table A-20. Immature plantation history

	Area managed (%)				
Analysis unit	**Age 1-10**	**Age 11-20**	**Age 21-30**	**Age 31-40**	**Age 41-50**
All analysis units except Red alder	100	100	100	100	100

A.4.3.3 Not satisfactorily restocked (NSR) areas

Land classified in the Arrowsmith TSA FIP file as type identity 4 or 9 is included in the current timber harvesting land base. These type identities indicate not satisfactorily restocked land base. Existing NSR is scheduled to be restocked within the regen delay period specified in Table A-19. according to its respective analysis unit.

A.4.3.4 Tree improvement

Information on the proportion of planting stock that is Class A (selected) was compiled for all analysis units. The average current genetic gain was weighted by the proportion of Class A stock used to arrive at the values in Table A-21. below. The following genetic gains have been included in volume tables for future regenerated stands in the base case. Volume tables for existing regenerated stands (generally 50 years and less) do not have tree improvement gains incorporated.

Table A-21. Tree improvement gains

Analysis unit	% volume gain at age 80
Fir	2.7
Cedar	1.3
Hemlock	1.9

A.4Forest Management Assumptions

A.4.4 Integrated resource management forest cover requirements

As noted in Section 4.1, "Management zones and tracking of multiple objectives (grouping)" the discussion on multiple objectives, forest cover requirements may be examined at a number of different levels. With the requirement to retain different forest characteristics across the landscape, it is important to identify how non-contributing forest (productive forest which does not contribute to the timber harvesting land base) may be considered in the forest cover requirements (i.e., maximum allowable disturbance or minimum area retention).

Table A-22a. Forest cover requirements for cutblock adjacency and visual values

Zone or group	Green-up height (metres)	Maximum allowable area not greened-up (%)	Area to apply constraint
Zone 1 VQO or RVQC = Retention	5	3	Crown forested area
Zone 1 VQO or RVQC = Partial retention	5	10	Crown forested area
Zone 1 VQO or RVQC = Modification	5	20	Crown forested area
Zone 2 VQO or RVQC = Retention	5	5	Crown forested area
Zone 2 VQO or RVQC = Partial retention	5	15	Crown forested area
Zone 2 VQO or RVQC = Modification	5	25	Crown forested area
Zone 3 IRM areas	3	25	Timber harvesting land base

Data source and comments:

VQO and RVQC constraints restrict the amount of harvesting within visual landscapes. Forest cover requirements for visual quality objectives have been determined using the documents *Procedures for Factoring Visual Resources into Timber Supply Analysis* (March 1998) and *Visual Mitigation Strategy Arrowsmith TSA* (November 1998). The strategy is in response to the chief forester's directive to achieve a 2% provincial buyback in timber supply through changes in visual management and divides the TSA into three types of zones — highly focal visual areas are zone 1, moderate focal visual areas are zone 2 and areas of low focal importance not covered by a VQO or RVQC are zone 3.

Zone 1 and zone 2 areas are managed to a green-up height of 5 metres as specified in the strategy. Zone 1 areas are managed to the mid range of the VQO or RVQC for per cent denudation and zone 2 areas are managed to the upper range of the VQO or RVQC for denudation. See Table 3 of the *Procedures for Factoring Visual Resources into Timber Supply Analysis* (March 1998) for the per cent denudation range. Those areas in zone 3, described above as IRM areas, are managed as per the *Forest Practices Code of British Columbia Act* and receive a minimum green-up height of 3 metres and a 25% denudation.

Table A-22b. Forest cover requirements for community watersheds and CWAP watersheds

Zone or group	Maximum allowable area not greened-up (% or hectares)	Hydrological recovery height (metres)	Area to apply constraint
Community watersheds	5% per 5 years	—	Crown forested area
Gordon River watershed	24%	9 metres	Crown forested area
Escalante River watershed	≤ 165 hectares harvested in the south sub-basin within the next 8 years	—	Timber harvesting land base

All stand heights shown in Tables A-22a. and A-22b. refer to top height (inventory definition).

Table A-22c. Forest cover requirements for landscape unit biodiversity in the base case

		% minimum old-seral stage retention by landscape unit			
		Biodiversity emphasis options			
Biogeoclimatic zone and variant	Natural disturbance type (NDT)	High	Intermediate	Low	Minimum age of old growth (years)
CWH	1	19	13	1st rotation=4	> 250
vh1, vh2				2nd rotation=9	
vm1, vm2				3rd rotation=13	
MH	1	28	19	1st rotation=6	> 250
mm1, mm2				2nd rotation=13	
				3rd rotation=19	
CWH	2	13	9	1st rotation=3	> 250
mm1, mm2				2nd rotation=6	
xm1, xm2				3rd rotation=9	
CDF	2	13	9	1st rotation=3	> 250
Mm				2nd rotation=6	
				3rd rotation=9	

A.4Forest Management Assumptions

A.4.4.1. Data management assumptions for the Clayoquot Sound area based on the scientific panel report

After many years of public participation and consultation regarding land and resource use in Clayoquot Sound, the provincial government in 1993 announced the Clayoquot Sound Land Use Decision (CSLUD). The decision zoned the Sound into three land use categories — protected areas, special management areas, and general integrated management areas. On October 1993, the provincial government announced the formation of the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound. The Panel was tasked with the objective of defining "sustainable", "world class", forest practices for the area. On May 30, 1995, the Panel submitted to government a three-volume report containing more than 120 recommendations on forest practices and First Nations issues. On July 6, 1995, government announced acceptance of the Panel's report and its intention to fully implement the Panel's recommendations.

Since 1995 government in consultation with the Clayoquot Sound Central Region Board, First Nations, licensees and others have been working on the implementation of the recommendations. In the area of planning, four out of 15 watershed unit plans are almost complete. Watershed unit planning delineates reserve areas and harvestable areas. As per the Panel's recommendations, once watershed plans are complete for the Sound, harvest levels will be based on these plans.

The Clayoquot portion of the Arrowsmith timber supply area will use the same timber supply model as the remaining portion of the Arrowsmith TSA. Clayoquot Sound will be treated as a geographically distinct unit with its own rate of harvest based on the following assumptions interpreted from recommendations by the Panel. Specifically, the recommendations that will be modelled in the base case for Clayoquot are:

- at least 40% of the Crown forest in a watershed (i.e., all reserves plus forest retained in harvestable areas) must be in age classes 8 and 9 (i.e., 141 years or older);
- a 1% watershed-based rate of cut. A maximum of 1% of the timber harvesting land base in each watershed can be harvested per year;
- visual areas modelled on a watershed basis, as per the percentages in Table A-22a.;
- The harvest flow from Clayoquot will be a maximum non-declining even-flow.

A.5Volume Estimates for Existing Stands

The variable density yield prediction (VDYP) model, version 6.4a developed and supported by the British Columbia Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-24. shows the volume estimates by analysis unit for existing natural stands.

Table A-23. Timber volume tables for existing natural stands (cubic metres)

Table	1	2	3	4	5	6	7
Age	Fir — Good East	Fir — Medium East	Fir — Poor East	Cedar — Good/Med East+	Cedar — Poor East	Hem/Bal — Good/Med East	Hem/Bal — Poor East
10	0	0	0	0	0	0	0
20	2	0	0	0	0	4	0
30	154	79	10	33	0	93	7
40	308	207	85	111	11	216	58
50	440	315	163	189	45	323	129
60	556	409	231	263	87	416	198
70	655	489	290	329	129	493	260
80	744	559	342	391	168	562	316
90	820	619	386	441	201	617	362
100	886	672	425	483	229	664	402
110	944	719	460	521	255	704	437
120	996	761	490	549	275	737	467
130	1 038	795	515	584	297	773	497
140	1 074	822	535	616	317	805	526
150	1 102	843	550	644	333	833	550
160	1 123	858	561	668	346	856	572
170	1 136	866	566	687	357	875	590
180	1 141	869	567	707	367	892	606
190	1 156	878	574	727	378	910	622
200	1 170	888	580	747	388	926	638
210	1 185	897	586	766	397	942	652
220	1 199	903	592	789	409	956	666
230	1 213	916	598	811	421	970	678
240	1 226	924	604	833	432	983	690
250	1 239	933	609	854	443	995	701
260	1 240	933	610	856	445	999	707
270	1 240	934	610	857	446	1 004	712
280	1 240	934	611	859	447	1 007	716
290	1 240	934	611	860	448	1 011	720
300	1 240	934	611	861	449	1 013	724
310	1 240	935	612	862	450	1 016	728
320	1 240	935	612	863	451	1 018	731
330	1 240	935	612	863	452	1 020	733
340	1 240	935	613	864	452	1 021	736
350	1240	935	613	864	453	1 023	738

(continued)

A.5Volume Estimates for Existing Stands

Table A-23. Timber volume tables for existing natural stands (cubic metres)

Table	10	11	12	301	302	303
Age	Alder leading	Other Alder	Other Decid/Conif East	Fir — Good West	Fir — Medium West	Fir — Poor West
10	4	0	0	0	0	0
20	57	24	0	9	0	0
30	138	128	8	173	79	15
40	213	240	40	329	201	107
50	269	331	87	465	305	193
60	312	408	133	582	395	266
70	332	465	175	683	471	325
80	349	516	214	772	537	377
90	364	559	250	849	595	421
100	378	598	284	917	646	459
110	390	632	315	976	691	494
120	400	661	345	1030	732	524
130	409	690	370	1074	763	548
140	417	716	387	1111	789	568
150	423	738	399	1140	809	583
160	428	758	406	1162	822	594
170	432	774	410	1176	829	601
180	434	788	409	1182	830	603
190	438	803	407	1197	838	609
200	442	818	409	1213	847	616
210	445	833	411	1228	856	623
220	449	848	413	1243	864	629
230	453	862	416	1258	873	635
240	456	876	418	1272	881	640
250	460	889	420	1286	888	646
260	460	894	421	1286	888	647
270	461	898	423	1287	889	648
280	461	902	425	1287	889	648
290	462	905	426	1287	889	649
300	462	908	427	1287	889	650
310	462	912	428	1287	889	650
320	463	914	429	1287	889	651
330	463	917	430	1287	889	651
340	463	920	430	1287	889	652
350	463	922	431	1287	889	652

(continued)

Table A-23. Timber volume tables for existing natural stands (cubic metres) (concluded)

Table	304	305	306	307	308	312
Age	Cedar — Good/Med West	Cedar — Poor West	Hem/Bal — Good/Med West	Hem/Bal — Poor West	Spruce — Good/Med West	Other Conif/Decid West
10	0	0	0	0	0	0
20	0	0	13	0	38	0
30	6	0	126	3	139	0
40	69	9	259	41	259	18
50	141	46	373	99	365	73
60	208	91	471	159	458	125
70	269	134	554	215	539	173
80	326	174	626	265	609	220
90	370	207	687	309	668	262
100	408	236	739	347	717	301
110	441	261	785	382	759	338
120	464	279	823	412	794	370
130	496	302	863	442	832	403
140	526	324	898	470	867	426
150	553	342	929	495	898	443
160	575	358	957	518	926	456
170	595	371	982	539	951	466
180	615	385	1 004	559	974	474
190	635	398	1 025	577	996	481
200	654	411	1 044	595	1 017	490
210	672	424	1 062	611	1 036	499
220	693	439	1 078	627	1 053	507
230	715	453	1 093	641	1 070	516
240	735	467	1 106	655	1 086	524
250	755	481	1 119	668	1 101	532
260	758	483	1 127	676	1 112	533
270	761	485	1 134	683	1 123	535
280	764	487	1 141	689	1 134	536
290	766	488	1 146	695	1 144	538
300	768	490	1 151	700	1 154	539
310	770	491	1 156	705	1 163	540
320	772	493	1 159	710	1 171	541
330	774	494	1 163	714	1 180	541
340	776	495	1 166	718	1 188	542
350	777	496	1 168	722	1 195	542

A.6Volume Estimates for Existing Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the British Columbia Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. The area-weighted site index and regeneration assumptions for each analysis unit were used as inputs to TIPSY. Section A.4.5, "Immature plantation history" and Table A-20. document which stands are assumed to be existing managed stands in the analysis. Table A-24. displays the volume tables for existing managed stands. Since the Arrowsmith TSA has a long history of stand management, certain factors like managing for root disease and tree improvement gains are not included in existing managed stands. For instance, the volumes shown in Table A-24. do not have any tree improvement gains, and OAF 2 reductions for root disease in fir stands are higher.

Operational adjustment factors (OAFs) used in existing managed stand yield table generation were:

OAF 1 of 15% (a constant percentage reduction at all ages to represent incomplete site occupancy, for example, small holes in a stand); and

OAF 2 of 5% (an increasing reduction, to represent losses such as decay that increase with stand age). OAF 2 increases in fir stands to 12.5% where root disease has been identified as a significant factor.

A.6Volume Estimates for Existing Regenerated Stands

Table A-24. Timber volume tables for existing regenerated stands (cubic metres)

Table	601	602	603	604	605	606	607
Age	Fir — Good East	Fir — Medium East	Fir — Poor East	Cedar — Good/Med East+	Cedar — Poor East	Hem/Bal — Good/Med East	Hem/Bal — Poor East
10	0	0	0	0	0	0	0
20	32	7	0	3	0	3	0
30	163	83	25	53	2	78	3
40	324	190	77	165	17	199	33
50	490	303	139	290	52	328	94
60	635	418	197	406	102	465	157
70	751	506	254	528	153	589	220
80	843	588	309	641	200	710	278
90	922	653	361	736	248	821	334
100	982	708	404	837	294	917	391
110	1 030	751	441	926	329	998	447
120	1 071	788	475	997	364	1 076	498
130	1 105	817	501	1 067	397	1 152	540
140	1 133	843	525	1 131	433	1 220	585
150	1 157	863	545	1 190	465	1 276	627
160	1 169	879	562	1 239	493	1 321	665
170	1 179	890	574	1 283	518	1 361	699
180	1 160	899	589	1 320	543	1 405	732
190	1 141	907	598	1 355	565	1 443	760
200	1 123	910	604	1 388	586	1 477	787
210	1 104	910	612	1 423	603	1 507	806
220	1 085	913	615	1 460	624	1 535	828
230	1 067	913	621	1 489	642	1 560	849
240	1 048	912	623	1 515	656	1 585	867
250	1 029	909	625	1 540	671	1 605	887
260	1 010	892	624	1 563	683	1 628	903
270	992	876	626	1 582	698	1 648	919
280	973	859	622	1 602	708	1 666	932
290	954	843	620	1 621	719	1 683	947
300	936	826	608	1 612	715	1 673	941
310	917	810	596	1 602	710	1 663	936
320	898	793	583	1 593	706	1 654	930
330	879	777	571	1 583	702	1 644	925
340	861	760	559	1 574	698	1 634	919
350	842	743	547	1 564	694	1 624	914

(continued)

A.6 Volume Estimates for Existing Regenerated Stands

Table A-24. Timber volume tables for existing regenerated stands (cubic metres)

Table	608	110	111	112	901	902	903
Age	Spruce — Good/Med East	Alder leading	Other Alder	Other Decid/Conif East	Fir — Good West	Fir — Medium West	Fir — Poor West
10	0	4	0	0	0	0	0
20	12	57	24	0	43	5	0
30	147	138	128	8	192	73	15
40	337	213	240	40	376	173	51
50	526	269	331	87	551	278	100
60	707	312	408	133	705	388	151
70	867	332	465	175	824	476	195
80	1 021	349	516	214	923	555	237
90	1 154	364	559	250	1 002	618	281
100	1 265	378	598	284	1 063	672	318
110	1 356	390	632	315	1 114	716	352
120	1 423	400	661	345	1 157	751	381
130	1486	409	690	370	1 192	780	406
140	1 536	417	716	387	1 215	804	428
150	1 576	423	738	399	1 197	825	445
160	1 609	428	758	406	1 178	840	462
170	1 641	432	774	410	1 160	853	475
180	1 668	434	788	409	1 142	864	485
190	1 659	438	803	407	1 123	869	492
200	1 649	442	818	409	1 105	874	502
210	1 640	445	833	411	1 086	875	507
220	1 631	449	848	413	1 068	877	512
230	1 622	453	862	416	1 050	878	516
240	1 613	456	876	418	1 031	876	519
250	1 604	460	889	420	1 013	873	522
260	1 594	460	894	421	994	869	523
270	1 585	461	898	423	976	853	524
280	1 576	461	902	425	957	837	522
290	1 567	462	905	426	939	821	521
300	1 558	462	908	427	921	805	511
310	1 549	462	912	428	902	789	500
320	1 539	463	914	429	884	773	490
330	1 530	463	917	430	865	757	480
340	1 521	463	920	430	847	740	470
350	1512	463	922	431	829	724	459

(continued)

A.6Volume Estimates for Existing Regenerated Stands

Table A-24. Timber volume tables for existing regenerated stands (cubic metres) (concluded)

Table	904	905	906	907	908	909	912
Age	Cedar — Good/Med West	Cedar — Poor West	Hem/Bal — Good/Med West	Hem/Bal — Poor West	Spruce — Good/Med West	Spruce — Poor West	Other Conif/Decid West
10	0	0	0	0	0	0	0
20	1	0	3	0	4	0	0
30	26	2	64	3	79	30	0
40	111	12	179	25	217	117	18
50	212	37	301	73	368	236	73
60	315	83	425	129	515	354	125
70	405	130	545	183	658	462	173
80	503	171	659	236	779	570	220
90	593	215	763	289	896	671	262
100	673	257	862	334	1 006	756	301
110	741	295	941	384	1 099	837	338
120	815	326	1 014	431	1 179	910	370
130	881	355	1 082	473	1 248	981	403
140	937	383	1 149	512	1 305	1 041	426
150	986	411	1 209	545	1 349	1 097	443
160	1 031	440	1 259	582	1 389	1 141	456
170	1 073	463	1 298	615	1 424	1 180	466
180	1 112	484	1 334	645	1 452	1 214	474
190	1 148	504	1 369	672	1 475	1 242	481
200	1 180	524	1 405	698	1 495	1 269	490
210	1 204	540	1 437	722	1 511	1 289	499
220	1 234	561	1 468	745	1 527	1 307	507
230	1 258	578	1 492	764	1 544	1 326	516
240	1 281	595	1 515	782	1 557	1 338	524
250	1 303	611	1 535	797	1 568	1 354	532
260	1 328	625	1 554	810	1 580	1 361	533
270	1 350	636	1 572	825	1 587	1 373	535
280	1 371	647	1 590	837	1 595	1 382	536
290	1 391	657	1 606	850	1 586	1 388	538
300	1 383	653	1 597	845	1 576	1 380	539
310	1 375	649	1 587	840	1 567	1 372	540
320	1 367	645	1 578	835	1 558	1 364	541
330	1 358	642	1 569	830	1 549	1 356	541
340	1 350	638	1 559	825	1 539	1 348	542
350	1 342	634	1 550	820	1 530	1 339	542

A.7Volume Estimates for Future Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. The area-weighted site index and regeneration assumptions for each analysis unit were used as inputs to TIPSY. Section A.4.5, "Immature plantation history" and Table A-20. document which stands are assumed to be existing managed stands in the analysis. Table A-25. displays the volume tables for future managed stands. Since the Arrowsmith TSA has a long history of stand management, certain factors like managing for root disease and tree improvement gains are included only in future managed stands. For instance, the volumes shown in Table A-25. include tree improvement gains (where applicable), and OAF 2 reductions for root disease in fir stands are lower than in existing regenerated stands.

Operational adjustment factors (OAFs) used in existing managed stand yield table generation were:

OAF 1 of 15% (a constant percentage reduction at all ages to represent incomplete site occupancy, for example, small holes in a stand); and

OAF 2 of 5% (an increasing reduction, to represent losses such as decay that increase with stand age). OAF 2 increases in fir stands to 10% where root disease has been identified as a significant factor.

A.7 Volume Estimates for Future Regenerated Stands

Table A-25. Timber volume tables for future regenerated stands (cubic metres)

Table	101	102	103	104	105	106	107
Age	Fir — Good East	Fir — Medium East	Fir — Poor East	Cedar — Good/Med East+	Cedar — Poor East	Hem/Bal — Good/Med East	Hem/Bal — Poor East
10	0	0	0	0	0	0	0
20	35	8	1	3	0	3	0
30	170	87	26	54	2	80	3
40	339	197	80	168	17	203	36
50	510	314	145	293	53	332	98
60	657	432	205	410	104	472	161
70	777	526	265	533	153	597	223
80	875	612	323	645	202	718	283
90	957	681	377	741	251	829	339
100	1 020	736	420	841	295	925	397
110	1 071	782	460	926	332	1 006	452
120	1 118	823	496	1 000	365	1 086	503
130	1 157	859	526	1 068	401	1 162	546
140	1 190	886	553	1 134	437	1 228	590
150	1 217	910	575	1 194	468	1 282	633
160	1 234	930	593	1 244	495	1 328	672
170	1 249	943	610	1 285	522	1 368	705
180	1 234	954	625	1 322	543	1 412	739
190	1 219	966	638	1 358	566	1 450	765
200	1 204	974	648	1 392	588	1 484	789
210	1 189	979	657	1 425	604	1 512	811
220	1 174	985	667	1 461	625	1 541	833
230	1 158	990	675	1 490	642	1 564	854
240	1 143	991	680	1 517	657	1 587	870
250	1 128	993	685	1 541	672	1 610	889
260	1 113	979	687	1 563	684	1 632	906
270	1 098	966	691	1 583	697	1 651	923
280	1 083	953	690	1 602	708	1 670	937
290	1 068	940	691	1 622	719	1 688	951
300	1 053	926	681	1 613	715	1 678	945
310	1 038	913	672	1 603	710	1 668	939
320	1 023	900	662	1 594	706	1 658	934
330	1 008	887	652	1 584	702	1 648	928
340	993	873	642	1 575	698	1 638	923
350	978	860	633	1 565	694	1 628	917

(continued)

A.7Volume Estimates for Future Regenerated Stands

Table A-25. Timber volume tables for future regenerated stands (cubic metres)

Table	108	110	111	112	401	402	403
Age	Spruce — Good/Med East	Alder leading	Other Alder	Other Decid/Con if East	Fir — Good West	Fir — Medium West	Fir — Poor West
10	0	4	0	0	0	0	0
20	12	57	24	0	46	6	0
30	147	138	128	8	200	78	16
40	337	213	240	40	392	181	53
50	526	269	331	87	573	290	106
60	707	312	408	133	729	403	157
70	867	332	465	175	854	492	203
80	1 021	349	516	214	956	576	246
90	1 154	364	559	250	1 038	644	292
100	1 265	378	598	284	1 104	700	334
110	1 356	390	632	315	1 160	747	368
120	1 423	400	661	345	1 210	784	398
130	1 486	409	690	370	1 247	818	425
140	1 536	417	716	387	1 273	846	450
150	1 576	423	738	399	1 259	868	470
160	1 609	428	758	406	1 244	888	488
170	1 641	432	774	410	1 229	904	504
180	1 668	434	788	409	1 214	917	516
190	1 659	438	803	407	1 199	928	527
200	1 649	442	818	409	1 185	935	538
210	1 640	445	833	411	1 170	942	545
220	1 631	449	848	413	1 155	947	555
230	1 622	453	862	416	1 140	950	559
240	1 613	456	876	418	1 125	953	566
250	1 604	460	889	420	1 111	955	571
260	1 594	460	894	421	1 096	955	575
270	1 585	461	898	423	1 081	942	578
280	1 576	461	902	425	1 066	929	580
290	1 567	462	905	426	1 051	916	580
300	1 558	462	908	427	1 036	903	572
310	1 549	462	912	428	1 022	890	564
320	1 539	463	914	429	1 007	877	555
330	1 530	463	917	430	992	865	547
340	1 521	463	920	430	977	852	539
350	1 512	463	922	431	962	839	531

(continued)

A.7Volume Estimates for Future Regenerated Stands

Table A-25. Timber volume tables for future regenerated stands (cubic metres) (concluded)

Table	404	405	406	407	408	409	412
Age	Cedar — Good/Med West	Cedar — Poor West	Hem/Bal — Good/Med West	Hem/Bal — Poor West	Spruce — Good/Med West	Spruce — Poor West	Other Conif/Decid West
10	0	0	0	0	0	0	0
20	1	0	3	0	4	0	0
30	28	2	67	3	79	30	0
40	113	12	182	25	217	117	18
50	214	38	305	75	368	236	73
60	316	85	433	133	515	354	125
70	409	130	551	187	658	462	173
80	506	173	668	239	779	570	220
90	596	217	773	291	896	671	262
100	677	258	869	338	1 006	756	301
110	746	296	946	390	1 099	837	338
120	820	327	1 023	435	1 179	910	370
130	885	357	1 092	478	1 248	981	403
140	938	385	1 155	515	1 305	1 041	426
150	988	413	1 216	550	1 349	1 097	443
160	1 032	440	1 264	587	1 389	1 141	456
170	1 077	465	1 306	620	1 424	1 180	466
180	1 115	487	1 339	651	1 452	1 214	474
190	1 149	505	1 376	679	1 475	1 242	481
200	1 180	524	1 410	705	1 495	1 269	490
210	1 205	542	1 442	727	1 511	1 289	499
220	1 235	561	1 473	747	1 527	1 307	507
230	1 259	579	1 498	767	1 544	1 326	516
240	1 281	596	1 520	785	1 557	1 338	524
250	1 304	612	1 539	799	1 568	1 354	532
260	1 328	625	1 558	814	1 580	1 361	533
270	1 352	636	1 576	826	1 587	1 373	535
280	1 371	647	1 594	841	1 595	1 382	536
290	1 392	657	1 609	852	1 586	1 388	538
300	1 384	653	1 600	847	1 576	1 380	539
310	1 375	649	1 590	843	1 567	1 372	540
320	1 367	645	1 581	838	1 558	1 364	541
330	1 359	642	1 571	833	1 549	1 356	541
340	1 351	638	1 562	828	1 539	1 348	542
350	1 343	634	1 553	823	1 530	1 339	542

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis identifies employment and income impacts, changes in government revenues and community impacts at various harvest levels and times in the future. Some of the assumptions used in the analysis are as follows:

- **Employment multipliers** — these multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. Employment multipliers are calculated based on analytical assumptions and data collected at a specific time. Consequently, the multipliers reflect industry and employment conditions at that time and may not accurately reflect future industry conditions. While generally good indicators when based on fairly recent information, older multipliers can be dated and may not reflect industry conditions at the time of analysis. In any impact analysis, the information should be considered as indicators of magnitude.
- **Employment coefficients** — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short term, employment coefficients may change in future as a result of changing market conditions or production technologies, for example.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Also, indirect and induced impacts will likely occur over a longer period, as business and consumer spending levels adjust to changes in harvest levels.
- **Processing thresholds** — processing job impacts are unlikely to occur in direct proportion to harvest changes (i.e., a 10% harvest reduction may not lead to a 10% processing employment reduction). Impacts are more likely to occur stepwise related to processing thresholds. A processing threshold is the level of a mill's timber supply where, when reached, will cause a mill to either lay off a shift or shut down the mill, temporarily or permanently. Accurately predicting a mill's threshold level is impossible. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels, or alternatively could underestimate impacts if a mill were to eliminate a shift. Over the medium to long term the impact figures should be reasonably accurate, however.
- **Government expenditures** — provincial government expenditures are more related to population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite harvest changes and any subsequent change in government revenues. However, public expenditures would likely change if community population levels change sufficiently. This would amplify the community impacts of forestry job losses or gains.
- **Proportional harvest reductions** — harvest reductions are assumed to be spread proportionately among all licensees and all forms of tenure.

B.2Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from British Columbia Statistics, Statistics Canada and local communities.

Person-years of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1. harvesting;
2. silviculture; and
3. timber processing.

Estimating employment and income impacts involves several steps. First, the current activity in each of the three sub-sectors was assessed. Then, indirect and induced employment and employment income impacts were estimated, using data from the British Columbia Statistics and Statistics Canada. Next, employment coefficients were calculated and applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes, were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log transport, log salvage, planning and administration functions. The employment multipliers used in this analysis define road building and maintenance work as indirect rather than direct employment. Including this employment in direct estimates would result in double counting.

Data on employment, place of residence and timber flows were obtained through a survey of licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of resident vs. non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1. TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2. Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, silviculture jobs were converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest.

Employment figures were also adjusted to reflect the residences of workers: those who lived within the TSA and those who lived outside the TSA. Employment in timber processing which is supported by chip by-products from milling operations was also estimated similarly.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employees associated with the forestry sector are those who supply goods and services to firms directly engaged in the basic forestry sector; for example, those who provide road maintenance services, fuel and office equipment and products. Induced employment consist of those who supply goods and services purchased by employees who are directly and indirectly engaged in the industry; for example, those who work in retail outlets. Indirect and induced employment figures were calculated using TSA and provincial employment multipliers.

Two sets of employment multipliers were used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the induced impacts associated with a change in direct employment.

B.2Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Arrowsmith TSA analysis are shown in Table B-1.

Table B-1. Total employment multipliers

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial coastal migration multiplier	Provincial coastal no-migration multiplier
Harvesting	1.66	1.43	2.02	1.72
Solid wood processing	1.57	1.36	2.31	1.94
Pulp	2.04	1.76	2.54	2.13

Sources: Horne, G., R. Riley, L. Ransom, and S. Kosempel. 1996. A provincial impact estimation procedure for the British Columbia forest sector. Ministry of Finance and Corporate Relations. 1999. The 1996 forest district tables.

Employment estimates of alternative timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in the future. Therefore, the employment estimates should be viewed as indicators of the magnitude of change rather than as precise estimates of changes in employment levels.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Income data are from Statistics Canada annual estimates of employment, earnings and hours. From 1998 to 2000, the average pre-tax annual income (less benefits) for sub-sectors of the forestry sector associated with the Arrowsmith TSA was about $47,100 for logging and forestry services; $44,900 for solid wood manufacturing; and $56,400 for the pulp and paper sector. The weighted average annual income for direct forestry workers in the Arrowsmith TSA was $47,540. The average annual income for indirect and induced employees averaged about $30,800. This figure is based on data for all service producing industries from the Statistics Canada Labour Force Survey, British Columbia Industrial Comparison, average weekly wage rates. Income taxes were calculated based on marginal tax rates of 23–28% with one-third of the total income tax accruing to the province.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated. Table B-2. summarizes provincial government revenue estimates.

Table B-2. Estimates of provincial government revenue — Arrowsmith TSA

Source of revenue	Average revenue 1998–2000 ($1999 millions)	Revenue ($/'000s m^3)
Stumpage, rents and royalties[a]	7.8	27,400
Industry taxes[b]	2.6	9,037
Provincial income tax[c]	1.8	6,182
Total government revenues	12.2	42,619

(a) Ministry of Forests.

(b) PricewaterhouseCoopers.

(c) Based on marginal tax rates from Revenue Canada.